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The effects of macroprudential policy on banks' profitability☆

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ABSTRACT

We estimate the effects of macroprudential policy on bank profitability, using a sample of 7250 global banks over 1990–2018. A number of policy measures have a negative impact on profitability, but these effects vary according to countries' economic development, bank type and time period. Macroprudential policy also adversely affects profitability of small and highly capitalised banks more than larger and less capitalised banks. Comparing our results with existing estimates of the impact of macroprudential policy on credit expansion, some measures are found to reduce lending but not profitability; others affect both negatively; and some affect profitability with no significant effect on lending. Since it is desirable for banks to make profits and thus be able to build up capital from retained earnings, our results suggest that care is needed in choosing measures according to their effects on bank profitability.

1. Introduction

It has been more than ten years since the global financial crisis of 2007–2008, which contributed to the widespread introduction of macroprudential policy as an essential tool to forestall or limit the impact of banking crises. Supporting this, there have been numerous empirical studies which provide robust evidence for the effectiveness of macroprudential policy in advanced, emerging and developing economies. Most of these studies have specifically focused on the effectiveness of macroprudential policy in the area of the financial sector where there is the most potential for systemic risk to develop, that is bank credit, bank risk and the housing market (see for example papers using macroeconomic data such as Cerutti, Claessens, and Laeven (2017), Kuttner and Shim (2016), Carreras, Davis, and Piggott (2018) and Akinci and Olmstead-Rumsey (2018), and papers using bank-level data such as Claessens, Ghosh, and Mihet (2013), Altunbas, Binici, and Gambacorta (2018), Gaganis, Lozano-Vivas, Papadimitri, and Pasiouras (2020) and Meuleman and Vander Vennet (2020)).

In this context, banks remain central in the financial sector in virtually all countries; a sound and profitable banking sector remains important for the effective functioning of the economy.[1] Furthermore, a robust and well-capitalised banking sector is better able to withstand negative shocks from financial disruptions and thus contribute to financial stability. However, despite the importance of profitability to banks' growth and stability, there have, to our knowledge, been no studies which assess the effect of macroprudential regulation on banks' overall profitability. Indeed, we believe there is a gap in the literature on macroprudential policy. Many extant studies use macroeconomic data and there is limited research using micro banking data in analysing the use of macroprudential policy. Whereas there is extensive research on bank profitability determinants at a micro level, this does not include assessment of the impact of macroprudential measures (although such studies do often include a measure of capital adequacy).

We contend further that, although the aim of macroprudential policy

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[1] This is despite the increased trend toward disintermediation of banks with the growth of capital and securities markets, improvement in financial system technology and the transformations of banks' operating environment. Banks' crucial role even in an economy with developed capital and securities markets was shown recently by the flight to bank credit lines by companies when securities markets closed to all but the most creditworthy firms in March 2020 as the Coronavirus took hold.

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is to limit financial instability at financial system level, extant macroprudential tools and related new regulations target the banking sector narrowly. Macroprudential action can be seen as an added cost to banks which in turn can affect banks' profitability as an unintended side effect. This impacts their net income, the cost of credit and their ability both to lend and to build up capital via retained earnings. Such measures could hence be counterproductive to financial stability in the longer term, as well as impacting on economic performance.[2]

In this overall context, the purpose of this article is to present empirical research showing effects of macroprudential policies on banks' profitability (measured by the return of average assets (ROAA) and return on average equity (ROAE)). Our empirical results, estimated by panel OLS with bank-level and time fixed effects, are based on a sample of 7250 global banks over the period 1990–2018. Besides filling gaps in the literature highlighted above, our work also aims to advance the understanding of how banks react to macroprudential regulations and hence the transmission process from policy to credit issuance.

In sum, we find that a number of macroprudential policies reduce profitability significantly, notably capital requirements, limits on foreign currency lending, taxation and in some estimates loan-loss provisioning requirements. Some interesting and contrasting results are found for three subsamples which divide the data between (i) banks in advanced countries, emerging market and developing economies, (ii) retail and universal banks, and (iii) pre- and post-subprime crisis. We also find that effects vary between banks of differing size and capitalisation, and the impact effects of tightening and loosening may differ from long-run effects. Finally, we undertook three robustness checks, firstly with additional variables capturing the quality of microprudential supervision, secondly with bank-clustered standard errors and country and time fixed effects, and finally entering all the macroprudential policies together rather than one-by-one. These underpin the validity of the main results of the paper.

Our results suggest some policies have a comparative advantage over others. This is because some measures are found to affect lending negatively but not profitability, others affect both negatively and some affect profitability with no significant effect on lending (although they may benefit banks' robustness). Since it is desirable for banks to make profits and thus bolster capital from retained earnings (Lee, 2015), our results suggest there is a need for care in choosing measures, according to their effect on bank profitability. Furthermore, in assessing the impact of policies by bank size, we find potentially undesirable structural effects since most policy measures penalise small banks (that could otherwise improve competition). There is also a potential penalty for banks that are adequately capitalised.

The rest of the paper is structured as follows: In Section 2 we present our hypotheses in the context of the existing empirical literature on the effects of macroprudential policy. Section 3 focuses on bank profitability in the empirical literature which underpins the key control variables in our study. Section 4 discusses the datasets used. Section 5 introduces the methodology. Section 6 presents the baseline results across the whole sample of banks. In Section 7 we examine the sample breakdowns by economy types, by bank types and before and after the subprime crisis. In Section 8 we outline two variants. Section 9 displays three robustness checks. Section 10 concludes.

[2] As discussed further in Section 2, there are parallels with the literature on costs of regulation such as Van den Heuvel (2008) and Tchana (2012) who suggested that although capital requirements limit moral hazard on the part of banks and hence are beneficial for financial stability, they are costly since they reduce the ability of banks to lend. They can hamper long-term economic growth, which is an unintended side effect of such regulations.

2. The effects of macroprudential regulation and the hypotheses of the paper

Developing from the literature that focuses on the effects of macroprudential policy, we assess the impact of such policy in the context of baseline equations, including appropriate control variables for each dependent variable. Particular background to our work are studies that highlight policy impacts on credit, a key aim of macroprudential policy, as well as articles that use microeconomic data. These provide both a point of comparison for direct and indirect effects of macroprudential policy as we develop our hypotheses, and also a methodological foundation for our work. A key point is that desired effects on credit may coincide with undesired effects on profitability, which also highlights our work as a contribution to the literature on costs of regulation.

There is empirical evidence which suggests that macroprudential policy is effective in reducing the build-up of financial system imbalances. There tends to be a focus on housing and credit market measures such as credit growth, house prices and the credit-to-GDP gap. Most extant papers use macroeconomic data.

Thus, for example, Cerutti et al. (2017) found that in a global sample of up to 119 countries over 2000–2013 the macroprudential index (MPI) (summing all the different types of instruments used over the period) was correlated with lower real non-financial private sector bank credit growth, especially in emerging markets, with a particular effect detected on real housing credit. Using a wider measure of financial imbalance, namely the aggregate credit-GDP gap, a study by Davis, Karim, and Noel (2017) using 43 countries showed a number of macroprudential tools are effective (notably when the gap is positive or growing), such as loan-to-value limits, debt-to-income ratios, dynamic provisioning and concentration ratios.

Akinci and Olmstead-Rumsey (2018) investigated the effectiveness of macroprudential policy in restraining the growth in real credit and asset prices for 57 advanced and emerging countries during 2001–2013. They found that macroprudential policies were often implemented alongside bank reserve requirements, capital flow restrictions, and monetary policy. Also, policies such as loan-to-value and debt-to-income ratios that target credit growth in certain specific sectors such as housing, are most effective. Carreras et al. (2018) looked at the transmission of macroprudential policies and its effectiveness in up to 19 OECD countries during the period 2000–2014 using three datasets from the IMF and BIS. Focusing on the omission of cointegration from other work in this field, their work highlighted a range of policies to be effective in restraining real house price growth and growth in real lending to households, as shown in Table 1.

Kuttner and Shim (2016) looked at a variety of non-interest rate policies' effects on house prices and housing credit for 57 economies over 1990–2012 and found debt-service-to-income limits and increases in housing-related taxes have significant negative effects on housing credit. Most recently, Alam et al. (2019) showed that that loan-targeted instruments have a significant impact on household credit, and a milder, dampening effect on consumption in a global sample from 1990 to 2016, while Bergant, Grigoli, Hansen, and Sandri (2020) assessed the benefit of macroprudential policies for resilience of emerging market economies to global shocks at a macroeconomic level.

A summary of the results of selected recent studies of effects on credit is provided in Table 1 below.

Methodologically, our work is most closely related to the relatively few studies that use microeconomic data. Claessens et al. (2013) looked at the effectiveness of macroprudential policy in reducing banking-system vulnerabilities as measured by individual bank asset growth for 48 countries and 2800 banks. Relating these policies to changes in individual banks' assets, they found that policies aimed at borrowers were effective in (indirectly) reducing the build-up of banking system vulnerability. Measures aimed at banks' assets and liabilities were very effective but as a group, countercyclical buffers showed less promise.

Several recent papers also focus on the effects of macroprudential

Table 1
Sign and significance of effects of macroprudential policy on credit in selected recent research.

Paper	Cerutti et al. (2017)	Davis et al. (2017)	Carreras et al. (2018)	Claessens et al. (2013)	Alam et al. (2019)
Dependent variable	Growth in real non-financial private sector domestic bank credit	Credit-GDP gap	Growth in real lending to households	Individual bank asset growth	Growth in household credit
Period	2000–13	2000–13	2000–13	2000–10	1990–2016
Coverage	Global	Global	Advanced	Global	Global
Loan-to-Value Ratio		(−)***	(−)***	(−)***	(−)**
Debt-to-Income Ratio	(−)**	(−)***			(−)***
Capital Surcharges on SIFIs				Na	Na
General Countercyclical Capital Buffer/Requirement				(−)***	Na
Time-Varying/Dynamic Loan-Loss Provisioning	(−)***	(−)**			(−)***
Leverage Ratio				Na	Na
Limits on Interbank Exposures	(−)**		(−)***	Na	Na
Concentration Limits		(−)***		Na	Na
Limits on Domestic Currency Loans				(−)**	(−)**
Levy/Tax on Financial Institutions			(−)***	Na	
Reserve Requirement Ratios					Na
Limits on Foreign Currency Loans	(−)*				Na
Loan-to-value ratio caps	(−)*	(−)***		Na	Na
FX and/or Countercyclical Reserve Requirements				Na	Na
All variables aggregated in total	(−)***	(−)***	(−)***	Na	(−)***
Borrower-targeted instruments (LTV_CAP plus DTI)	(−)**	(−)***		(−)***	(−)***
Financial-Institution targeted instruments	(−)***	(−)***	(−)***	(−)***(a)	(−)*

Notes: Instruments were entered one at a time. *** Significant at 1%, ** significant at 5%, * significant at 10%. (a) applies to asset-related tools only, not buffers. Studies 1–4 used the 2015 GMPI database of macroprudential instruments, while study 5 used the 2019 IMAPP database, the most recent version of which is used in the current study (see Section 4 below). The credit-to-GDP gap is the difference in percentage points between the total non-financial private sector credit-to-GDP ratio and its trend (see BIS, 2016). Kuttner and Shim (2016) using a different database, found that loan-to-value, debt-to-income and housing taxes affected growth of housing credit.

policies on individual bank risks. As for effects on credit growth, we may expect that if policy reduces risk, it may also reduce profitability (in line with portfolio theory). For example, Altunbas et al. (2018) assessed the impact of macroprudential policy on two measures of bank risk, the change in the expected default frequency and the change in the Z score. The sample covered 3177 individual banks in 61 countries over 1990–2012. They found a significant negative effect of broad categories of macroprudential policies on bank risk. The negative effect on bank risk was greatest in an upturn and for banks that are small, poorly capitalised and with more wholesale funding. Ezer (2019) similarly found that bank characteristics affects the impact of macroprudential policy on risk (measured by loan loss provisions and non-performing loans ratios) and argued that country-level variables may be misleading for financial system stability.

Gaganis et al. (2020) sought to assess how macroprudential policy and corporate governance together might impact on bank risk, with a sample of 365 banks in 50 countries over 2002–2017. They found that macroprudential policy interacts positively with the quality of corporate governance (measured by the bank's commitment and effectiveness toward following corporate governance principles[3]) in determining risk taking. The better is corporate governance in this sense, the greater the reduction in risk-taking from macroprudential policies, although this interaction effect was only found in advanced countries and not emerging market economies.

Meuleman and Vander Vennet (2020) investigated the impact of macroprudential policies on systemic risk for EU banks from 2000 to 2017. They found that whereas macroprudential policies – notably controls on credit expansion and exposure limits - do reduce the component of systemic risk related to individual bank risk, the component related to risks arising from systemic linkages is aggravated by some policies. For some retail banks, this was seen as linked to risk-shifting behaviour, whereby in response to limits on exposures to certain counterparties or a need to disinvest in certain assets enforced by macroprudential policies, such banks may shift their exposures to make them more vulnerable to market or business cycle shocks.

Generally, as shown in Table 1, the empirical analyses typically find that the most commonly significant variables for reducing credit growth are provisioning measures, limits of loan growth, limits on foreign currency lending, loan-to-value limits, debt-to-income limits and tax measures. Meanwhile, policies such as capital and liquidity requirements and limits on foreign exchange positions may enhance resilience (Alam et al., 2019). We thus hypothesise that where macroprudential policies reduce the ability of banks to lend (or take risks), there should be a significant and negative effect on bank profitability as net interest income and fees from loan issuance may fall, unless offset by increases in non-interest income, reductions in non-interest costs or provisions. Lower profitability in turn reduces banks' ability to accumulate capital, as well as to distribute dividends. Banks can only optimise profits through variable choices that they control in the context of their business model (as in Beck, De Jonghe, and Schepens (2013) and Davis, Karim, and Noel (2020b)). Accordingly, in the absence of regulation, they would maximise profits given a chosen level of risk in light of their private preferences on costs and benefits. By imposing limits on banks' choices, macroprudential policy is likely to reduce profits, although as the studies cited above note, it may also at the same time reduce risk.

Our Hypothesis 1 is therefore as follows: If macroprudential policy is effective in reducing financial system imbalances, as measured by indicators of credit growth (see Table 1 and the related references outlined above), there should also be a significant and negative effect on banks' profitability. This is because banks will earn less interest income and

[3] This is the ASSET4 measure produced by Datastream.

also less non-interest fees from new loan issuance. They may also need to hold a larger proportion of low-return liquid assets, if lending is restricted. We thus anticipate a negative relationship between macroprudential policies that reduce financial imbalances (according to the literature) and bank level profitability.

An alternative Hypothesis 2 is that banks' profitability may not be affected by policies that reduce financial imbalances, as banks may be able to shift their activities from interest earning to non-traditional activities and increase overall non-interest income when lending is constrained by macroprudential measures. Or alternatively, they may be able to increase non-controlled and/or riskier lending[4] and other asset classes to more than offset the decline due to the macroprudential policy. For example, loan-to-value limits may reduce mortgage lending but raise corporate lending and securities holdings (Acharya, Bergant, Crosignani, Eisert, & McCann, 2020). A further effect may be to shift financial activities outside regulatory parameters (Cizel, Frost, Houben, & Wierts, 2016) and increase cross-border borrowing by domestic or foreign banks (Aiyar, Calomiris, & Wieladek, 2014; Cerutti et al., 2017). This risk-shifting effect may link in turn to moral hazard generated by the safety net of deposit insurance and lender of last resort for banks that consider themselves "too big to fail". Accordingly, we may find a zero or even positive effect of the effect on profitability, even for policies found to be effective in reducing financial imbalances.

We suggest that the ability of banks to offset the effect of macroprudential policies on profitability is likely to be greater in advanced countries and for larger banks who have a wider scope for adjustment. This is consistent with Cerutti et al. (2017) who noted weaker effects of macroprudential policy on asset prices and credit in developed and more financially open economies, suggesting some policy avoidance and/or disintermediation, and Altunbas et al. (2018) who found a greater negative effect of macroprudential policy on risk for small banks. These should find parallels in profitability.

We note that there are some parallels with the hypotheses and the literature on the costs of regulation. This tends to focus on the effects of capital requirements on lending, and suggests it may generate wider economic costs. Such costs may be an unintended consequence of policies aiming to enhance robustness. Similarly, macroprudential policymakers do not aim to reduce bank profitability, but this may become an unintended side-effect of the principal targets of policy such as lowering of financial imbalances or enhanced robustness of the system. We therefore suggest that any negative effects of macroprudential policy on profitability are another form of regulatory cost.

As an example of the cost of regulation literature, Van den Heuvel (2008), using data for the US from 1993 to 2004, found that the welfare cost of then-current Basel capital adequacy minima of 8% was to reduce consumption by up to 1%. This is because it reduced the ability of US banks to create liquidity. Similarly, Tchana (2012) using an overlapping-generations model, found that higher capital adequacy requirements hamper economic growth by shifting banks' portfolios from more productive, risky investment projects toward less productive and safer investment projects. Further relevant studies with similar results include Noss and Toffano (2016) for the UK and Naceur, Marton, and Roulet (2018) for the US and Europe and Roulet (2018) for Europe.

On the other hand, the sign of the effect of capital regulation on lending can vary, and we expect similar variance for bank profitability and macroprudential policies. Kim and Sohn (2017) suggested that bank capital requirements have a significant positive effect on lending once banks retain sufficient liquid assets, using quarterly data for US banks over the period 1993 to 2010. Positive results were also found for US banks by Naceur et al. (2018). Aiyar et al. (2014) indicated that regulated banks (UK-owned banks and resident foreign subsidiaries) reduce lending in response to tighter capital requirement but, concurrently, unregulated banks (resident foreign branches) increase lending in response to tighter capital requirements. Going beyond the capital/lending nexus, Pasiouras, Tanna, and Zopounidis (2009) found that banking regulations that enhance market discipline and empower supervisory authorities increase both cost and profit efficiency of banks.[5]

3. Deriving control variables from the literature on banks' profitability

It is essential to capture other determinants of bank profitability in order to accurately gauge the effect of macroprudential policy and avoid omitted-variables bias. Hence, the further background to our modelling in terms of empirical framework and choice of control variables is the extensive literature on the determinants of bank profitability, with key papers including Goddard, Molyneux, and Wilson (2004); Goddard, Liu, Molyneux, and Wilson (2013), Pasiouras and Kosmidou (2007), Athanasoglou, Delis, and Staikouras (2006), Petria, Capraru, and Ihnatov (2015), Chronopoulos, Liu, McMillan, and Wilson (2015), Saona (2016) and Korytowski (2018). We note that many of these studies are regional or national in focus, and accordingly our paper breaks relatively new ground by using global data.

The empirical literature most commonly measures banks' profitability by the returns on average assets (ROAA) and equity (ROAE). ROAA reflects how a bank uses its assets to generate profits, while ROAE measures the performance of a bank based on its average shareholders' equity, equivalent to the return to shareholders on their equity. The returns figure can be divided into a number of subcomponents, namely net interest income, non-interest income, non-interest costs and provisioning. Some articles in this field (such as Alessandri and Nelson (2015), Borio, Gambacorta, and Hofmann (2017) and Davis, Karim, and Noel (2020a)) focus more specifically on one or more of these subcomponents, notably net interest income and the related net interest margin.

The factors that influence banks' profitability in the literature are typically split in two groups: internal and external determinants. Internal determinants include bank-specific factors which are based on financial statement information such as bank size, financial structure (capital/leverage ratios), risks incurred and management efficiency. They can be seen as related to the banks' business model as in Beck et al. (2013) and Davis et al. (2020b). The external determinants relate to industry and macroeconomic factors which are beyond banks' control, which include market concentration, competition, economic growth and inflation as well as monetary policy. Macroprudential measures such as loan-to value or debt-to-income measures would also tend to fall in the external category, although the outcome of capital adequacy regulations in terms of bank leverage per se is an internal measure. While the studies clearly indicate the importance of the respective control variables, their sign and significance vary between studies.

3.1. Internal factors

Bank size may have a negative effect on bank profitability, at least beyond a certain point. For example, Goddard et al. (2004) using a

[4] See for example Jimenez et al. (2017).

[5] A further criticism of studies that suggest capital regulation is costly is that they do not take into account the benefit of regulation in reducing the probability of a financial crisis. This may more than offset the cost in terms of the net present value of benefits of regulation. Barrell et al. (2009) calculated that the cost of tighter regulation is small in the long run, and since the costs of crises are potentially high, then tighter regulation would be appropriate, as the cost of the crisis (appropriately weighted by the effect of the measure on crisis probability) outweighs the cost of the loss of economic output. Davis, Liadze, and Piggott (2019) looking at the UK, Germany and Italy in a similar manner using the NiGEM global econometric model, suggested that the hypothetical introduction of macroprudential measures such as countercyclical capital buffers prior to the subprime crisis would have reduced the incidence of the crisis and improved macroeconomic performance.

sample over 1992–1998, found that whereas larger European banks can benefit from economies of scale, these become exhausted as size increase. Pasiouras and Kosmidou (2007) found that over 1995–2001, although larger European banks are likely to have a higher degree of product and loan diversification, bank size has a negative effect on profitability. Similarly, Korytowski (2018) found that bank size had a negative and significant effect on ROAA while it is insignificant for ROAE for European banks over 2011–2015.

Regulation's effect on bank profitability is generally assessed in extant work via the effect of capital structure (generally measured as equity/assets), which will be partly driven by capital adequacy regulation. Goddard et al. (2004) found a positive effect, suggesting that higher capital ratios allow banks greater flexibility in taking advantage of new business opportunities, which in turn allow for improved profitability. Petria et al. (2015) found a positive but weakly significant effect of capital adequacy on ROAA but not ROAE for EU-27 banks over 2004–2011. Athanasoglou et al. (2006) also found that a higher solvency ratio has a positive effect on profitability for Southeast European banks over 1998–2002, as it reduces risk-taking and funding costs. On the other hand, US results for Hoffmann (2011) over 1995–2007 supported a negative relationship between capital adequacy and bank profitability, suggesting highly capitalised banks are over-cautious and ignore potentially profitable trading opportunities. Similarly, Topak and Talu (2017) found that capital adequacy (equity/ total assets) has a negative and significant effect on bank profitability for Turkish banks over 2005–2015.

Credit risk exposure is an integral part of banking, as well as being important for the stability of the financial system. For example, Athanasoglou et al. (2006) found that higher exposure to credit risk, measured by loan-loss provisions to total loans, is associated with lower bank profitability. Miller and Noulas (1997), using US banking data for the period 1984–1990, also found a negative and significant relationship between credit risk (loan-loss provisions to total loans ratio) and profitability (ROA), as banks with high-risk loans tend to have a higher accumulation of unpaid loans. Indeed, Petria et al. (2015) found a negative effect of the non-performing loans/gross loans ratio on profitability. However, Korytowski (2018) found European commercial banks' risk appetite (ratio of loan-loss reserves to gross loans) to be an insignificant determinant of banks' profitability (ROAA and ROAE) during the post-crisis period.

Liquidity risk exposure is measured by Petria et al. (2015) as the ratio of loans to customer deposits. When this ratio increases, then bank profitability deteriorates, as banks with a higher loan/deposit ratio are more dependent on costly and volatile wholesale funds. Korytowski (2018) found a similar result in that liquidity (measured inversely as the deposits/loans ratio) has a positive and significant effect on bank profitability (ROAA) but the result is insignificant for ROAE. An alternative measure of liquidity risk as used in Mergaerts and Vander Vennet (2016) is the deposits/liabilities ratio, which shows the degree of dependence on non-deposit funding, that are more subject to runs than deposit funding in the presence of deposit insurance.[6] They found a positive relation of this measure to profitability for European banks over 1998–2013.

Management cost decisions, measured by a lower cost/income ratio, was found by Athanasoglou, Brissimis, and Delis (2008) to benefit profitability of Greek banks over 1985–2001. Similarly, Goddard et al. (2013) found that the cost-to-income ratio has a negative and significant effect on bank profitability for European banks from 1992 to 2007. Korytowski (2018) and Petria et al. (2015) also found the cost to income ratio to have a negative and significant effect on both ROAA and ROAE.

Diversification, captured by a higher share of non-interest income to total income, was found to benefit profitability by Goddard et al. (2013) and Petria et al. (2015). However, Saona (2016) suggested that there is a negative relationship between revenue diversification and profitability measured by the net interest margin for Latin American banks over 1995–2012.

3.2. External factors

Besides the above-mentioned internal factors, most empirical studies of bank profitability include external control variables i.e., industry and macroeconomic factors.

3.2.1. Industry factors

Market competition in profitability studies has traditionally been proxied by concentration measures such as the Herfindahl-Hirschman Index (HHI). For example, Demirgüç-Kunt and Huizinga (1999), using bank-level data for 80 countries over 1988–1995, reported a positive and statistically significant relationship between bank concentration and bank profits, and found that larger banks tend to have higher profit margins. Goddard et al. (2013) and Petria et al. (2015) also found that concentration had a positive and significant effect on bank profitability. On the other hand, Korytowski (2018) found that concentration (HHI) had a negative and significant effect on both ROAA and ROAE. Mirzaei, Liu, and Moore (2013), utilising a global sample of banks over 1999–2008, found market share to be more relevant than concentration as a determinant of profitability for advanced countries, but neither was significant for emerging market economies. Dietrich and Wanzenried (2011) found that over 1999–2009, Swiss banks were able to increase profitability by exploiting market domination (measured using the HHI).

Concentration can be criticised as a measure of competition, since it does not allow for the impact on margins of potential competition from outside the sector (e.g., from cross border lending, securities markets or non-bank lending), and thus the possibility of contestability, which depends in turn on whether there are barriers to entry and exit in the market. Advances in such contestability over time, due for example to deregulation and technological advances, may explain the differing results of Korytowski (2018) from the earlier literature.

A potentially superior measure to concentration as a measure of market power is the Lerner Index, derived from a translog cost function, which is a measure of the price-cost margin. It can be seen as a proxy for current and future profits stemming from pricing power, and it varies at the level of the individual bank. Under perfect competition the index is zero as the output price (marginal revenue) equals marginal cost, and "normal" economic profits are zero.[7] Bank profitability studies using the Lerner Index include Maudos and Solis (2009) with data for Mexican banks over 1993–2005, and Kasman, Tunc, Vardar, and Okan (2010) looking at old and new EU members over 1995–2006. Both studies found that the Lerner Index had a positive and significant effect on bank profitability, implying lower competition raises profitability.

3.2.2. Macroeconomic factors

Studies such as Athanasoglou et al. (2008) and Chronopoulos et al. (2015) that include macroeconomic factors typically found a positive relationship between *inflation and GDP growth* on the one hand and bank profitability on the other. Saona (2016) suggested that a positive link to inflation may arise when bank managers correctly anticipate inflation and increase net interest margins, which allows earnings to increase faster than costs. On the other hand, he argued that GDP growth may

[6] As noted by Altunbas et al. (2018), this is also a measure of a bank's contractual strength. "Banks with a large amount of deposits will adjust their deposit rates by less (and less quickly) than banks whose liabilities are mainly composed of variable rate bonds that are directly affected by market movements" (ibid, p411).

[7] Danisman and Demirel (2019) comment that the Lerner measure is flexible, with no need to define the relevant market, without major data requirements and is straightforward to interpret.

impact negatively on bank profitability, since it appears that in periods of substantial economic growth, banks adjust by reducing their profit margins. In contrast, Korytowski (2018) found that the rate of inflation had a negative and significant effect on both ROAA and ROAE in the period after the 2007–2008 financial crisis.

Financial/ banking crises can be seen as both industry and macroeconomic variables. Studies of their impact on bank profitability are sparse.[8] One exception is Bouzgarroua, Jouidaa, and Louhichib (2018) who examined the profitability of domestic and foreign banks before, during and after the financial crisis using 170 banks operating in France over the period 2000–2012, and found foreign banks were less affected by the crisis than domestic banks. Xiao (2009) and Adelopo, Lloyd-King, and Tauringana (2018) found little or no effect of the crisis on profitability of French and West African banks respectively.

In the literature, only a few studies have included a monetary policy or an *interest rate* variable as determinants of bank profitability, with tests typically finding no significant impact. Those that do include a significant interest rate effect (such as Alessandri and Nelson (2015) and Borio et al. (2017)), typically focused on the net interest margin and not the ROAA/ROAE as in our work and the bulk of the literature. In terms of profitability, any effects of interest rates on the net interest margin could be offset in by shifts in other components of total returns.

4. Datasets employed

Our key data stem from both the Fitch-Connect database, which provides annual financial information for banks, and the latest version of the IMF IMAPP survey data on macroprudential instruments (Alam et al. (2019), IMF (2020)). Our sample is drawn from banks operating in 92 countries, comprised of 35 advanced countries and 57 emerging market and developing economies. There are 7250 banks (3723 from advanced countries and 3527 from emerging market and developing economies, see Table A.1.1).[9] The types of banks included are universal commercial banks, retail and consumer banks, universal wholesale banks, and Islamic banks. Investment banks and private banks are excluded due to different balance sheet and income structures, as are bank holding companies, to avoid double counting. As in Claessens et al. (2013), the number of banks for each country covers at least the top 100 banks based on total assets, or less if fewer banks exist on the Fitch-Connect database.[10] The banking data collected are unconsolidated (where available), which also allows for the reporting of foreign bank subsidiaries in each country. All financial statement data are annual and in US dollars. The period of coverage for the banking data is 1990 to 2018, annually, in line with the IMAPP database introduced below. As noted by Altunbas et al. (2018), a global sample of countries with different macroprudential policy experiences should reduce the risk of omitted-variables bias.[11]

The IMF's integrated Macroprudential Policy (iMaPP) Database, originally constructed by Alam et al. (2019) covers 135 countries on a monthly basis over 1990 to 2018 (IMF, 2020). There are 17 survey instruments, which are summarised into seven summary instruments following Alam et al. (2019). The data on individual tools captures tightening (+1) and loosening (−1) and accordingly only provides categorical information on policy actions (i.e., they show simply whether the policy is tightened or loosened but not the severity of application or easing). We cumulated the observations following the approach of Bergant et al. (2020) working with this dataset, Meuleman and Vander Vennet (2020) with the ECB MaPPED database and earlier work by Akinci and Olmstead-Rumsey (2018), as well as the earlier IMF database highlighted in Cerutti, Correa, Fiorentino, and Segalla (2016). Thereafter, we annualised the data in line with the frequency of the banking data.[12] We thus provide an approximate measure of the stance and stringency of macroprudential regulation at each point in time, with a higher index showing a tighter stance. As noted by Meuleman and Vander Vennet (2020), cumulation is important since as pointed out by Cerutti et al. (2017) and Akinci and Olmstead-Rumsey (2018), macroprudential measures can have effects not just initially but also in the longer term, and the specific point at which the policy becomes binding is not observable.

Our regressions accordingly show the effectiveness of tools at each point in time as applied in practice across the countries concerned, given the typical intervention undertaken.[13] However, as argued in Akinci and Olmstead-Rumsey (2018), Forbes (2018) and Bergant et al. (2020), measurement imprecision, common to virtually all existing work on macroprudential policy, creates attenuation bias for coefficient estimates of macroprudential policy variables. This should bias the analysis against finding significant effects associated with macroprudential regulation rather than generate spurious evidence.

We used the IMAPP dataset since it covers the countries that are included in the empirical analysis and is based on survey data collected from official reporting agencies to the IMF such as central banks and financial regulatory authorities. It has been used in recent work such as Alam et al. (2019) and Bergant et al. (2020). Table 2 shows the list of instruments with a description of their nature. Table 3 lists a series of summary measures and describes their method of calculation. The corresponding descriptive statistics for the cumulated indices are shown in Table A.2.1.

Alam et al. (2019) summarised the IMAPP data and showed that the number of countries using macroprudential policies has been increasing since 1990, reaching a peak in 2012 when 90% of their sample had used at least one tool. Even before the global financial crisis, two-thirds of their sample had used at least one tool, although emerging market and developing economies used policies more overall than did advanced countries prior to the crisis.

5. Baseline model

We used insights from the literature on the determinants of banks' profitability, as summarised in Section 3, to guide our study of macroprudential policy effects on banks' profitability, thus advancing the literature cited in Section 2. We constructed a baseline model which seeks to include all relevant control variables, before adding the macroprudential policy variables one by one.

In line with the bulk of the literature, we measure our dependent variable, bank profitability, by the returns on average assets (ROAA) and equity (ROAE). Then, for independent control variables, we selected the standard and common bank-specific, industry and macroeconomic variables noted in Section 3 to explain the determinants of banks' profitability (see Table 4 below). As shown in the fourth column, for many of these variables, the results in the research literature (Section 3) show mixed results.

Using the information above, we formulated the following baseline

[8] There are studies of the impact of crisis on bank failures such as Cariboni et al. (2016) and Yang (2016).

[9] In contrast, the Claessens et al. (2013) dataset was for 2800 banks in 48 countries.

[10] For countries with more than 100 banks, we selected the top 100 in 1995, 2005 and 2015 so as to obtain a spread over the full time period. All these banks are included in the data for the years they existed in order to capture the top 100 banks over the sample as far as possible, and to avoid the loss of data points.

[11] We suggest that our consistent use of bank and time fixed effects should further reduce this risk.

[12] This procedure means that where a policy was introduced in mid-year, the observation for that year reflects this. Introduction in July, for example, cumulated and then annualised gives an observation of 0.5.

[13] We note also that countries may have had a different level of macroprudential regulation in 1990, thus affecting cross-country rankings.

Table 2
Instruments in the IMF IMAPP integrated Macroprudential Policy Database (2020).

Individual macroprudential instruments	Abbreviation	Definition
Countercyclical buffer	CCB	A requirement for banks to maintain a countercyclical capital buffer. Implementations at 0% are not considered as a tightening in dummy-type indicators.
Conservation buffer	Conservation	Requirements for banks to maintain a capital conservation buffer, including the one established under Basel III.
Capital requirements	Capital	Capital requirements for banks, which include risk weights, systemic risk buffers, and minimum capital requirements. Countercyclical capital buffers and capital conservation buffers are captured in the above measures respectively and thus not included here.
Leverage requirements	LVR	A limit on leverage of banks, calculated by dividing a measure of capital by the bank's non-risk-weighted exposures (e.g., Basel III leverage ratio).
Provisioning requirements	LLP	Loan-loss provision requirements for macroprudential purposes, which include dynamic provisioning and sectoral provisions (e.g., housing loans).
Credit growth limits	LCG	Limits on growth or the volume of aggregate credit, the household-sector credit, or the corporate-sector credit by banks, and penalties for high credit growth.
Loan restrictions	LoanR	Loan restrictions, that are more tailored than those captured in "LCG". They include loan limits and prohibitions, which may be conditioned on loan characteristics (e.g., the maturity, the size, the LTV ratio and the type of interest rate of loans), bank characteristics (e.g., mortgage banks), and other factors.
Limits on Foreign Currency Loans	LFC	Limits on foreign currency (FC) lending, and rules or recommendations on FC loans.
Loan-to-value limits	LTV	Limits to the loan-to-value ratios, including those mostly targeted at housing loans, but also includes those targeted at automobile loans, and commercial real estate loans.
Debt-to-income limits	DSTI	Limits to the debt-service-to-income ratio and the loan-to-income ratio, which restrict the size of debt services or debt relative to income. They include those targeted at housing loans, consumer loans, and commercial real estate loans.
Levy/Tax on Financial Institutions	Tax	Taxes and levies applied to specified transactions, assets, or liabilities, which include stamp duties, and capital gains taxes.
Liquidity measures	Liquidity	Measures taken to mitigate systemic liquidity and funding risks, including minimum requirements for liquidity coverage ratios, liquid asset ratios, net stable funding ratios, core funding ratios and external debt restrictions that do not distinguish currencies.
Loan to deposit limits	LTD	Limits to the loan-to-deposit (LTD) ratio and penalties for high LTD ratios.
Limits on FX operations	LFX	Limits on net or gross open foreign exchange (FX) positions, limits on FX exposures and FX funding, and currency mismatch regulations.
Reserve requirements	RR	Reserve requirements (domestic or foreign currency) for macroprudential purposes. This category may currently include those for monetary policy as distinguishing those for macroprudential or monetary policy purposes is often not clear-cut.
SIFI surcharges	SIFI	Measures taken to mitigate risks from global and domestic systemically important financial institutions (SIFIs), which includes capital and liquidity surcharges.
Other macroprudential measures	Other	Macroprudential measures not captured in the above categories—e.g., stress testing, restrictions on profit distribution, and structural measures (e.g., limits on exposures between financial institutions).

Source: Alam et al. (2019), IMF (2020). The database covers a sample from 1990 to 2018, with monthly data which we have cumulated over time and annualised.

Table 3
Summary instruments derived from the IMF IMAPP integrated Macroprudential Policy Database (2020).

Summary macroprudential instruments	Abbreviation	Definition
All measures	MAPP-INDEX	Sum-total of the instruments listed in Table 2
Loan-targeted measures	LOAN-TARGETED	Sum of the "Demand" and the "Supply-loans" instruments.
Demand-targeted measures	DEMAND	Sum of loan-to-value limits and debt-to-income limits
Supply-targeted measures	SUPPLY-ALL	Sum of all the instruments listed in Table 2 except loan-to-value limits and debt-to-income limits
Loan-supply targeted measures	SUPPLY-LOANS	Sum of provisioning requirements, credit growth limits, loan restrictions, limits to the loan to deposit ratio, and limits to foreign currency loans
General supply targeted measures	SUPPLY-GENERAL	Sum of reserve requirements, liquidity requirements, and limits to FX positions.
Capital-related supply measures	SUPPLY-CAPITAL	Sum of leverage, countercyclical buffers, conservation buffers, and capital requirements.

Source: Alam et al. (2019), IMF (2020). The database covers a sample from 1990 to 2018 with monthly data, which we have cumulated over time and annualised.

ordinary least squares (OLS) model of the determinants of banks' profitability for ROAA and ROAE.

$$Y_{ijt} = \alpha + \beta \mathrm{Internal}_{ijt-1} + \mathrm{Þ}\mathrm{Macro}_{jt} + \theta \mathrm{Industry}_{ijt-1} + \varepsilon_{it} \quad (1)$$

where i denotes the individual bank, j refers to the country in which bank i operates and t indicates time period. The dependent variable, Y_{ijt} denotes the measure of banks' profitability (ROAA or ROAE). Following the discussion in Section 3, these control variables come in three groups, denoted *internal*, *macro* and *industry*. Since we included a range of variables in each group, the terms ß, Þ and θ in Eq. (1) represent vectors of coefficients and not individual coefficients.

The set of variables denoted by *Internal* is the vector of bank internal factors. The bank-level independent variables are lagged by

Table 4
Measures and determinants of banks' profitability.

Variables	Abbreviation	Measure/source	Literature relation (+/−)
Return on Average Assets	ROAA	Net Income/ Average Total Assets	
Return on Average Equity	ROAE	Net Income/ Average Total Equity	
Bank Size	LNSIZE	Logarithm of Total Assets	+/−
Unadjusted capital adequacy	LEVERAGE	Equity/ Total Assets	+/−
Credit Risk	CREDRISK	Non-performing loans/ Gross Loans	−
Liquidity/Contractual Risk	LIQRISK	Deposits/Total liabilities	+/−
Management Efficiency	COSTINC	Total Operating Expenses/ Total Income	+/−
Diversification	DIVSIF	Non-Interest Income/ Gross Revenue	+/−
Competition	LERNER	Lerner Index	+
Banking Crisis	BCRISIS	Laeven and Valencia (2018)	+/−
Economic growth	RGDPG	Real GDP growth rate (annual %)	+/−
Inflation	INFLAT	CPI Inflation rate (annual %)	+/−

Data sources: Fitch-Connect, World Bank, Laeven and Valencia (2018) and authors' calculations. Column 4 is based on the literature survey in Section 3. Note that a larger Lerner Index implies lower levels of competition.

one year to avoid the potential issues of endogeneity and reverse causality (as in papers such as Davis and Karim (2019), de-Ramon, Francis, and Straughan (2018) and Beck et al. (2013)).[14] As shown in Table 4 above, these are respectively; bank size, which is the logarithm of total assets; leverage, the ratio equity/total assets; credit risk, measured by non-performing loans/gross loans; liquidity and contractual risk, which declines with a higher deposits/liabilities ratio (as in Mergaerts and Vander Vennet (2016) cited in Section 3)[15]; management efficiency, as shown by the cost-income ratio of total operating expenses/total income; and diversification, which is the ratio of non-interest income/gross revenue.

Industry refers to banking-industry variables, which are twofold. As discussed above, the chosen competition variable is the Lerner Index, which varies by bank.[16] Note that we do not employ the Panzar-Rosse H statistic unlike Schaeck and Cihák (2012), Davis and Karim (2019) and others, owing to some technical issues arising with this measure.[17] In common with other bank-level variables, Lerner is lagged, since the issue of endogeneity and reverse causality could arise. The banking crisis variable, as defined by Laeven and Valencia (2018), is a dummy variable that is coded as one in the year the crisis starts until the year it was over and is otherwise zero. It can be seen as both an industry and a macro variable. The other *Macro* variables are economic growth, measured by the real GDP growth rate (annual %) and inflation, which is the CPI Inflation rate (annual %), both obtained from the World Bank's World Development Indicators Database. The banking crisis variable, inflation and growth are entered as current-period variables since issues of endogeneity and reverse causality are less likely to arise.

Appendix 2 presents the summary statistics across the sample, which are in line with those in other studies such as Davis and Karim (2019). Appendix 2 also shows the correlation matrix for the variables across the sample. We find that none of the variables are highly correlated except for the moderate correlation between management efficiency and Lerner Index at −0.67, and ROAA and the Lerner Index at 0.57. No other correlations exceed 0.5.

We estimated the baseline model by panel OLS with lagged bank-level independent variables, as in Mirzaei et al. (2013), Petria et al. (2015) and Davis and Karim (2019). As is common in the literature, all variables are winsorised at 99% to avoid an impact of outliers. We used White (1980) cross-sectional standard errors and covariance (corrected for degrees of freedom) to reduce the impact of heteroskedasticity (as in Davis & Karim, 2019).

The estimated baseline OLS model (Eq. (1)) was then evaluated using the Hausman test to accommodate the appropriate cross-sectional variation, that is between fixed and random effects models. The results of the Hausman test for the full sample suggested that a fixed-effects model is appropriate. The results are supported by highly significant Likelihood Ratio tests, which suggest bank and temporal fixed effects are present. Accordingly, we use bank-level and time fixed effects in our baseline model used for the principal results.[18] The combined model thus controls, via time dummies, for unobservable factors that change over time but are constant over entities, and it also controls, via bank dummies, for unobservable factors that differ across entities but are constant over time.[19]

The macroprudential instruments (see Tables 2 and 3) were tested one by one using the baseline estimation model (Eq. (1)). This is in line with the standard approach in the literature on macroprudential policy cited in Section 2 such as Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018), Carreras et al. (2018) and Gaganis et al. (2020). Like the bank-level independent variables in the model, the macroprudential instruments were lagged by one period, again in line with the approach

[14] The endogeneity problem could also be mitigated by use of Generalised Method of Moments (GMM) estimation using instrument variables. A good instrument would be a variable which is highly correlated with regressors, but not with the error terms. One and two lagged values of regressors and dependent variables are conventionally used as instrument variables. However, as also argued by Mirzaei et al. (2013), the use of lagged variables implies further loss of degrees of freedom that would vitiate our results by markedly reducing the size of the unbalanced panel dataset. Furthermore, GMM is commonly used in cases where there is a large lagged dependent variable and fixed effects, while our own estimation suggests that this is not a major issue, as in preliminary estimation we found at most a small lagged dependent variable and accordingly omitted it from our estimation.

[15] We also tried the loan/deposit ratio as a measure of liquidity risk, but it was not significant. The deposits/liabilities measure was also employed in Meuleman and Vander Vennet (2020) and Altunbas et al. (2018).

[16] The Lerner index is a measure of the price-cost margin; it can be seen as a proxy for current and future profits stemming from pricing power, and it varies at the level of the individual bank. Under perfect competition the index is zero as the output price (marginal revenue) equals marginal cost, and "normal" economic profits are zero. The Lerner index is positive as a firm's market power increases and price rises above marginal cost in a quantity-setting oligopoly model, with the limiting case being monopoly. We derived the Lerner Index following Anginer, Demirgüç-Kunt, and Zhu (2014), Beck et al. (2013), Weill (2013) and Davis and Karim (2019) using a restricted translog cost function.

[17] Notably, Shaffer and Spierdijk (2015) show that under a variety of conditions, an H Statistic exceeding zero may still be consistent with substantial market power in banking; a value over zero can arise in a variety of oligopoly settings, all consistent with a positive Lerner Index.

[18] Results of a model including supervision quality variables and a model with bank-clustered standard errors and country and time dummies are shown in Section 9 for assessing robustness.

[19] As noted by Danisman and Demirel (2019), it is not possible to have country as well as bank dummies since they are collinear, but they argue that as each bank is associated with one country, country effects are captured by bank fixed effects.

Table 5
Regression results for return on average assets (ROAA) and return on average equity (ROAE) for all countries, for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Global sample	
Dependent variable	ROAA	ROAE
Constant	6.432***	54.89***
	(7.3)	(6.5)
LNSIZE(−1)	−0.278***	−2.117***
	(7.5)	(5.8)
LEVERAGE(−1)	1.52***	−16.06***
	(2.9)	(4.2)
CREDRISK(−1)	−2.677***	−26.16***
	(9.3)	(10.1)
LIQRISK(−1)	0.253*	3.639***
	(1.9)	(3.2)
COSTINC(−1)	−0.00672***	−0.071***
	(8.9)	(9.0)
DIVSIF(−1)	0.0888	0.547
	(0.9)	(0.6)
LERNER(−1)	1.934***	11.53***
	(10.0)	(8.5)
BCRISIS	−0.302***	−4.456***
	(3.5)	(4.5)
RGDPG	0.0921***	0.793***
	(8.0)	(12.2)
INFLAT	0.00101	0.0175
	(0.2)	(0.5)
R-squared	0.53	0.47
R-squared (adj.)	0.47	0.4
Standard error	1.45	12.41
F-statistic	9.18	7.17
Prob(F-statistic)	0	0
Periods included	28	28
Cross sections included	4435	4416
Observations	41,013	40,759

Note: Independent variables' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The variables are winsorised at 99% except BCRISIS. White (1980) cross-sectional standard errors and covariance (corrected for degrees of freedom) are used. ROAA is the return on average assets, ROAE is the return on average equity, LNSIZE is the log of total assets, LEVERAGE is unadjusted capital adequacy (equity/assets), CREDRISK is credit risk (non-performing loans/gross loans), LIQRISK is liquidity/contractual risk (deposits/total liabilities), COSTINC is management efficiency (cost/income ratio), DIVERSIF is diversification (the share of non-interest income in gross revenue), LERNER is the Lerner Index as a measure of competition, BCRISIS is a dummy for banking crisis, RGDPG is the real economic growth rate in terms of GDP and INFLAT CPI Inflation. For more details, see Table 4.

of these authors. This is because we consider that the risk of endogeneity and reverse causality[20] is present, as macroprudential authorities react to bank-level developments. It also allows for lags in the adjustment of banks' behaviour to macroprudential measures,[21] as is also the case for the "long and variable lags" that have been found for effects of monetary policy (dating from Friedman (1961)).

[20] As argued by Bergant et al. (2020), use of cumulative measures reduces the risk of reverse causality since the level of regulation is more likely to be predetermined, being largely the result of easing or tightening in past years, in contrast to changes in regulation that may respond to current developments. Meanwhile Meuleman and Vander Vennet (2020) suggest that micro data reduces the risk of reverse causality from developments in a single bank, but it could arise when all banks show similar behaviour.

[21] As suggested by Cerutti et al. (2017), lags are justified as "we cannot expect immediate impact from the adoption of these policies" (ibid, p210). Akinci and Olmstead-Rumsey (2017) suggest that lags are needed "in order to address the possible endogeneity of macro- prudential measures" (ibid, p41) with respect to financial conditions. Aysan et al. (2015) found empirically a lag of 2–3 quarters in effectiveness of policy in Emerging Market Economies.

6. Baseline results

Table 5 reports the empirical results for banks' profitability measured by ROAA and ROAE (Eq. (1) above). The ROAA model is estimated using 4435 banks with 41,013 observations whilst the ROAE model includes 4416 banks and 40,759 observations. Both models were estimated over 28 periods, since most of the independent variables are lagged by one period. The F-test indicates that the variables included in the models provide statistically significant explanations of bank profitability.

As shown in Table 3, the literature shows conflicting results for bank size. Part of the literature suggests that larger banks can benefit from economies of scale up to a point, as they are able to raise capital at lower cost, thus increasing profit. On the other hand, researchers such as Korytowski (2018) and Pasiouras and Kosmidou (2007) found a significant and negative effect of size on banks' profitability. Consistent with their findings, our empirical results in Table 5 suggest indeed that bank size has a significant and negative effect on profits measured by ROAA and ROAE during the period, which indicate that large banks suffered lower profitability than average over 1990–2018. We suggest that this is not solely due to a greater impact of various crises on larger banks, as the crisis variable is also significant.

The leverage ratio has a negative and significant effect on the ROAE but a positive impact on the ROAA over the period under review. The result for the ROAE is consistent with the results for the link to profitability in Hoffmann (2011) and Topak and Talu (2017). This could be due to the effect of the evolving Basel Accord capital requirements. The result for ROAA is consistent with Goddard et al. (2004), who suggested that higher capital ratios allow banks greater flexibility in taking advantage of new business opportunities, which allows for improved profitability.

Overall, managing risk, and in some respects especially credit risk, has become one of the most central issues in banking and for regulators (as reflected in the Basel Accords). This is because poor credit-risk practises have been an underlying factor leading to many banking crises, such as the 2007–2008 subprime crisis in the US (FCIC (2011)), as well as the banking crises and economic slowdown in Scandinavian countries over the period 1990–1991 (Sandal, 2004). The negative sign we find for credit risk is consistent with studies such as Petria et al., 2015 (measured by non-performing loans/gross loans) and Athanasoglou et al. (2006) (who used provisions/gross loans). This shows that deteriorating asset quality will have a negative and significant effect on bank profitability. Liquidity/contractual risk also impacts on banks' profitability in our sample, whereby as in Mergaerts and Vander Vennet (2016), a higher deposit/liabilities ratio (implying less risk of runs due to deposit insurance), raises profitability.

The cost/income ratio, defined as total operating expenses/total income, has a significant and negative relationship to banks' profitability. Our result for this measure of managerial efficiency is similar to the results reported by Goddard et al. (2013), Petria et al. (2015) and Korytowski (2018). In our estimations, diversification measured by non-interest income/gross revenue has an insignificant effect on both ROAA and ROAE, in contrast to studies such as Goddard et al. (2013) and Petria et al. (2015), who found that banks which focused more on non-traditional lines of business and were more diversified and more profitable, on average.

The competition measure, the Lerner Index, has a positive and significant effect on both ROAA and ROAE. This suggests that banks were able to exploit their greater market power to increase profitability, as in Maudos and Solis (2009) and Kasman et al. (2010). The banking crisis variable is negative and significant as a determinant of banks' profitability as measured by ROAA and ROAE, which is what we expected, albeit contrary to some of the country-level results in the research literature on bank profitability, such as Xiao (2009) and Adelopo et al. (2018), where they indicated that the financial crisis had limited effects on banks in the specific countries concerned.

Table 6
Individual macroprudential instruments results for all countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Global sample	
Dependent variable	ROAA	ROAE
Individual macroprudential instruments		
CCB (−1)	0.075	1.061**
	(1.3)	(2.0)
CONSERVATION (−1)	0.027	−0.04
	(1.0)	(0.1)
CAPITAL (−1)	−0.046***	−0.352***
	(3.7)	(2.8)
LVR (−1)	0.107**	0.065
	(2.1)	(0.1)
LLP (−1)	−0.047	−0.555
	(1.2)	(1.3)
LCG (−1)	0.153*	−0.427
	(1.7)	(0.4)
LOANR (−1)	0.045**	0.152
	(2.5)	(1.2)
LFC (−1)	−0.118**	−0.792*
	(2.1)	(1.9)
LTV (−1)	0.021	0.14
	(1.1)	(0.9)
DSTI (−1)	0.009	0.086
	(0.2)	(0.2)
TAX (−1)	−0.061*	−0.331
	(1.8)	(1.3)
LIQUIDITY (−1)	−0.0033	0.132
	(0.1)	(0.6)
LTD (−1)	−0.038	0.666
	(0.4)	(0.8)
LFX (−1)	−0.063	−0.334
	(1.5)	(0.9)
RR (−1)	0.0096	0.083
	(1.4)	(1.0)
SIFI (−1)	0.043	0.274
	(0.9)	(0.5)
OTHER (−1)	0.025	−0.027
	(1.3)	(0.1)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

Table 7
Summary macroprudential instruments results for all countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Global sample	
Dependent variable	ROAA	ROAE
Summary macroprudential instruments		
MAPP-INDEX (−1)	−0.0004	−0.0106
	(0.1)	(0.3)
LOAN-TARGETED (−1)	0.0086	0.00595
	(1.1)	(0.1)
DEMAND (−1)	0.013	0.092
	(1.1)	(0.8)
SUPPLY-ALL (−1)	−0.00059	−0.0139
	(0.1)	(0.3)
SUPPLY-LOANS (−1)	0.0103	−0.069
	(0.7)	(0.4)
SUPPLY-GENERAL (−1)	0.0056	0.07
	(1.0)	(1.1)
SUPPLY-CAPITAL (−1)	−0.0235**	−0.215**
	(2.3)	2.0)

Note: The summary macroprudential instruments' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

In terms of the macroeconomic factors, our results are in line with the literature for real GDP growth, as it has a positive and significant effect on banks' profitability over the analysis period. Growth in the economy should result in an increase in banks' profitability, as suggested by Athanasoglou et al. (2008) and Chronopoulos et al. (2015). The insignificance of inflation, in contrast to Saona (2016), may suggest that banks were not fully anticipating inflation in the period under review.

Using the above model as a baseline, we next discuss the effects of the macroprudential instruments. Tables 6 and 7 outline the effects of macroprudential instruments on banks' profitability measured by ROAA and ROAE (using the baseline model shown in Table 5 and adding the policy variables one at a time).[22]

Overall, in the period 1990–2018, the results for individual macroprudential policies (Table 6) suggest that capital requirements and limits on foreign currency lending had a significant negative effect on profitability for both ROAA and ROAE. A negative effect is also found for tax measures according to the ROAA. Meanwhile, we find a positive effect on ROAA in this global sample from leverage measures, limits on loan growth and other lending measures. A positive effect is also found for the countercyclical capital buffer limits in the ROAE estimates. In respect of the summary measures (Table 7), we find only capital-related supply measures to be significant, with a negative effect on both the ROAA and ROAE.

Comparing these results with Table 1, we accept that Hypothesis 1 is true for some key and commonly used macroprudential tools such as capital requirements, foreign currency lending limits and tax measures, that is, banks' profitability is negatively affected when macroprudential policy is effective in reducing financial system imbalances. The implication is that although macroprudential policy limits credit-driven booms and (in case of capital requirements) enhances short-term robustness, it may in turn reduce robustness in the long term as it limits scope to accumulate capital via retained earnings. However, this is not true for all macroprudential measures, where a number of measures are shown to have a zero or positive and significant effect on profitability (such as provisioning requirements, limits of loan growth, loan-to-value limits and debt-to-income limits) but which the literature suggests may still affect credit growth (as shown in Table 1).

We also note that the global sample may obscure significant effects in subsamples, given that the global banking system is not homogeneous. Accordingly, we now go on to present a number of subsample and variant results for advanced and emerging market and developing economies, for different bank types (retail and consumer banks versus universal banks), and for before and after the subprime crisis. As background, we provide in Appendix Table A.2.5 the differing mean levels of key control variables across subsamples.

[22] Details of all the coefficients and diagnostics for each regression are available from the authors.

7. Results for subsamples

7.1. Results for advanced and emerging market and developing economies

To further develop the analysis, we tested the macroprudential instruments according to a country division between emerging market and developing economies and advanced countries. There are 57 emerging market and developing economies and 35 advanced countries in the sample (see Appendix 1 for a list of countries and number of banks). As shown in Table A.2.5, key differences between banks in these countries over the period concerned include higher profitability in emerging market and developing economies, which may be associated with higher credit risks and somewhat lower levels of competition, and is complemented by higher capital/asset ratios. Banks in advanced countries are larger on average, while measures of liquidity, management efficiency and diversification are comparable. Emerging market and developing economies experienced higher growth and also inflation over 1990–2018, but as the subprime crisis was centred in advanced countries, they average less years of ongoing banking crises.

It is important to note that emerging market and developing economies have a longer history of using macroprudential policies than advanced countries (Cerutti et al., 2017). The latter mainly adopted macroprudential policies after the subprime crisis. Among the findings of that paper were that emerging market regulators tend to focus on foreign exchange policies, suggesting a dual objective of stabilising the country's foreign exchange market, while advanced countries tend to use more borrower-based policies which specifically target consumer spending and the real estate market. Also, they found a weaker effect on credit growth and real estate prices in more developed and more financially open economies, suggesting some avoidance of the policy and/or disintermediation. Emerging markets were seen to have a higher exposure to external shocks (including capital flows) and more imperfect, less liberalised financial systems and to be less open which are all likely to increase the effectiveness of macroprudential policies.

Before discussing the macroprudential instruments results separately for emerging market and developing economies and advanced countries, we first note the main ROAA and ROAE estimation models. Appendix Table A.3.1 shows the results of the banks' profitability models, measured by ROAA and ROAE (with bank-level and time fixed effects) for the period 1990–2018. We suggest that these results are themselves a contribution to the literature on bank profitability, since most profitability studies cited in Section 3 are for banks from specific regions, small groups of countries or individual countries.

Briefly, in Appendix Table A.3.1, the main regression models for both emerging market and developing economies and advanced countries are consistent in sign and significance with the global results in Table 5. The main differences are that diversification, which was insignificant in the global sample, has a positive effect on profitability in emerging market and developing economies but negative in advanced countries. Inflation boosts profitability only in advanced countries, suggesting advanced country banks anticipate inflation more sensitively. A positive leverage ratio effect on the ROAA is only present for emerging market and developing economies.

Tables 8 and 9 show the macroprudential instrument results for emerging market and developing economies and advanced countries separately over the period 1990–2018. As in the estimates above for the full sample, the macroprudential instruments were tested one by one using the main regression models, and as is the case for the independent bank-level control variables in the model, the macroprudential instruments were lagged by one period.

The effect of macroprudential policies is far more marked for emerging market and developing economies than for advanced countries. This may suggest that banks in advanced countries indeed have more scope for countervailing action, such as lending to non-restricted sectors or cross-border, and also boosting non-interest income, or alternatively that the policies are more severely and strictly applied in emerging market and developing economies.[23] In line with this, we note that according to the World Bank surveys of bank regulation and supervision shown in Barth, Caprio, and Levine (2013) and Anginer, Bertay, Cull, Demirgüç-Kunt, and Mare (2019), there are more activity restrictions on financial institutions in emerging market and developing economies. The mean level of the summary variable derived from the surveys for activity restrictions is 7.3 for emerging market and

Table 8
Individual macroprudential instruments results for emerging market and developing economies and advanced countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Advanced countries		Emerging market and developing economies	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Individual macroprudential instruments				
CCB (−1)	−0.012	−0.166	0.476***	5.58***
	(0.4)	(0.4)	(5.0)	(4.7)
CONSERVATION (−1)	−0.033	−0.155	0.055	−0.152
	(1.5)	(0.5)	(1.6)	(0.5)
CAPITAL (−1)	−0.021	−0.228	−0.0675***	−0.554***
	(1.0)	(1.0)	(3.9)	(3.9)
LVR (−1)	0.102	1.112	0.141*	−0.203
	(1.3)	(1.1)	(1.9)	(0.3)
LLP (−1)	−0.053	−0.105	0.0082	−0.517
	(1.1)	(0.2)	(0.2)	(1.1)
LCG (−1)	Na	Na	0.198**	−0.429
			(2.0)	(0.4)
LOANR (−1)	0.033	0.555*	0.061***	0.13
	(1.1)	(1.7)	(2.7)	(0.8)
LFC (−1)	−0.0054	−0.52	−0.173*	−0.943
	(0.1)	(1.0)	(1.7)	(1.3)
LTV (−1)	−0.0021	0.118	0.062**	0.215
	(0.1)	(0.6)	(2.2)	(1.0)
DSTI (−1)	−0.032	−0.521	0.018	0.842
	(0.8)	(1.3)	(0.2)	(1.1)
TAX (−1)	−0.058**	−0.401	−0.048	−0.267
	(2.4)	(1.3)	(1.0)	(0.8)
LIQUIDITY (−1)	0.029	0.607**	−0.034	−0.172
	(1.5)	(2.1)	(1.0)	(0.6)
LTD (−1)	0.425	4.713	−0.024	0.47
	(1.1)	(1.0)	(0.3)	(0.7)
LFX (−1)	0.117	1.953	−0.014	−0.248
	(0.6)	(0.8)	(0.3)	(0.7)
RR (−1)	−0.027	−0.47*	0.025***	0.162*
	(1.6)	(1.8)	(2.8)	(1.8)
SIFI (−1)	0.0091	0.138	0.019	−0.42
	(0.4)	(0.4)	(0.2)	(0.4)
OTHER (−1)	−0.031	−0.503	0.051*	0.374
	(1.1)	(1.4)	(1.9)	(1.3)

Note: The macroprudential instruments coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.1 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. Na not applicable as the instrument has not been used by many advanced countries over the estimation period. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

[23] We note that the Barth et al. (2013) and Anginer al et (2019) supervision variables used in the variant in Section 9 do not show that supervision is less rigorous in emerging and developing countries than in advanced countries. The mean level of the supervisory power variable is 11.4 for emerging and developing countries, and 10.5 for advanced countries.

Table 9
Summary macroprudential instruments results for emerging market and developing economies and advanced countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Advanced countries		Emerging market and developing economies	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Summary macroprudential instruments				
MAPP-INDEX (−1)	−0.0071	−0.062	0.0054	−0.0021
	(1.4)	(1.0)	(1.0)	(0.1)
LOAN-TARGETED (−1)	0.00004	0.045	0.027**	0.022
	(0.1)	(0.5)	(2.3)	(0.2)
DEMAND (−1)	−0.006	−0.021	0.045**	0.269**
	(0.5)	(0.1)	(2.5)	(2.0)
SUPPLY-ALL (−1)	−0.006	−0.058	0.006	−0.0098
	(1.0)	(0.7)	(1.0)	(0.1)
SUPPLY-LOANS (−1)	0.016	0.269	0.034*	−0.076
	(0.9)	(1.4)	(1.7)	(0.4)
SUPPLY-GENERAL (−1)	−0.011	−0.174	0.019**	0.122
	(0.8)	(0.8)	(2.6)	(1.6)
SUPPLY-CAPITAL (−1)	−0.012	−0.104	−0.043***	−0.447***
	(1.0)	(0.7)	(2.8)	(3.5)

Note: The summary macroprudential instruments coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.1 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

developing economies and 5.7 for advanced countries. This result is also in line with those of Cerutti et al. (2017) as noted above.

As in the global sample, negative effects are found for bank profitability in emerging market and developing economies in the case of capital requirements and foreign currency lending limits, although the latter are only significant for the ROAA. Meanwhile, positive effects on profitability are found for countercyclical buffers and reserve requirements for both profitability measures. Profitability also displays a positive relationship with leverage measures, measures affecting loan growth and loan-to-value limits. Summary measures for capital supply are significant and negative, as in the full sample, for both measures of profitability, while demand measures have a positive effect. We also find positive effects on the ROAA for loan-targeted measures, loan-supply and supply-general measures.

As regards advanced countries, we find that tax measures adversely affect the ROAA, as do reserve requirements for the ROAE. Positive effects are found for the ROAE in respect of loan measures and liquidity measures. None of the summary measures are significant.

These results are consistent with the results in Tables 6 and 7 above for all countries, except that some of the significance comes from advanced countries (tax measures) and others from emerging market and developing economies (capital requirements and foreign currency lending limits). We find additional effects for each country group, underlining the importance of assessing subsamples. Accordingly, we continue by separating retail and consumer banks from universal commercial banks.

7.2. Bank types – retail and consumer banks and universal commercial banks

We estimated ROAA and ROAE models with bank and time fixed effects based on the two most common types of banks in the FitchConnect dataset. These are retail and consumer banks and universal commercial banks, respectively. Retail and consumer banks are typical mass-market banks in which individual customers use local branches of larger commercial banks. Retail and consumer banking aims to be the one-stop shop for as many retail financial services as possible on behalf of individual retail clients such as checking accounts, savings accounts, personal loans, lines of credit and mortgages. Universal banks typically provide similar facilities but also a wider variety of financial services, including also insurance, corporate and investment banking services.

Referring again to Table A.2.5, we see that a key difference between these types of bank is that universal banks are less dependent on net interest income, with more diverse activities reflected in a greater proportion of non-interest income (35.6% compared to 27.9%). Other measures are broadly comparable, except there is higher credit risk for universal banks also, and somewhat higher capital and profitability. Note that the sample for the retail banks is relatively small compared with the universal banks (around 13,000 observations as opposed to over 26,000).

The ROAA and ROAE model results based on subsectors of banks (see Appendix Table A.3.2) are again largely consistent with the global results in Table 5. The main difference is that the deposit/liability ratio is not significant for retail and consumer banks, whereas it is highly significant for the universal banks. The latter banks being active in a wider range of markets, may be more likely to actively manage liabilities (this may also be reflected in a lower average level of deposits/liabilities for universal banks shown in Table A.2.5).

In term of the macroprudential instruments, the results in Tables 10 and 11 show that the effect of macroprudential instruments on profitability of universal banks are mostly in line with the results of the baseline (Tables 6 and 7 above), since capital requirements are negative and significant for both measures of profitability, and foreign currency lending limits for the ROAA. Meanwhile, there are positive effects for loan measures in ROAA and for countercyclical buffers (for both measures and not solely the ROAE). In addition to the baseline, there are negative effects for ROAA in the case of loan to deposit ratios and for ROAE for provisioning requirements. There are also positive effects for ROAA from loan-to-value limits and other measures. In terms of summary measures, again we find that the supply-capital aggregate is significant as in Table 7, but in addition there are positive effects for demand measures on both measures of profitability.

The results for retail and consumer banks show contrasts both with the full sample and the universal banks. In contrast to the other samples, we do not find capital requirements significant at the 10% level, although we do get the same result for taxation as the global sample for the ROAA. Results specific to the sample of retail banks include negative effects on both measures of profitability from other macroprudential measures, and on the ROAA from debt-to-income limits. This may reflect a greater dependence on household lending than for universal banks. There are also positive effects on profitability from measures affecting the loan to deposit ratio and on the ROAA from the conservation buffer, leverage ratio and credit growth limits. None of the summary measures are significant.

We note that an overall lesser effect of macroprudential policy on retail banks than universal banks, as we find here, is consistent with results of Meuleman and Vander Vennet (2020) who found risk shifting to be greater for this class of institution in Europe.

7.3. Estimates for the subperiods 1990–2006 and 2007–2018

All of the samples and subsamples so far have covered the entire period from 1990 to 2018, but as noted above, there has been much more employment of macroprudential measures, notably in advanced countries, since the subprime crisis, while the crisis itself could have affected responses to macroprudential measures. Accordingly, we tested separately for the periods 1990–2006 and 2007–2018, before and after

Table 10
Individual macroprudential instruments results for retail and universal banks for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Retail and Consumer Banks		Universal Banks	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Individual macroprudential instruments				
CCB (−1)	0.028	0.455	0.152*	1.798***
	(0.5)	(0.8)	(1.9)	(2.8)
CONSERVATION (−1)	0.071*	0.173	−0.0046	−0.223
	(1.8)	(0.4)	(0.2)	(0.8)
CAPITAL (−1)	−0.038	−0.456	−0.04**	−0.366**
	(1.3)	(1.6)	(2.3)	(2.4)
LVR (−1)	0.209**	1.673	0.062	−0.478
	(2.2)	(1.5)	(1.5)	(1.0)
LLP (−1)	−0.038	−0.611	−0.06	−0.604*
	(0.8)	(1.1)	(1.5)	(1.7)
LCG (−1)	0.303*	−0.565	0.098	−0.489
	(1.8)	(0.3)	(1.1)	(0.5)
LOANR (−1)	−0.0034	0.251	0.048**	0.119
	(0.1)	(0.6)	(2.3)	(0.7)
LFC (−1)	−0.031	−0.302	−0.123**	−0.704
	(0.3)	(0.3)	(2.2)	(1.6)
LTV (−1)	−0.029	−0.152	0.034*	0.235
	(0.9)	(0.4)	(1.7)	(1.5)
DSTI (−1)	−0.114*	−0.908	0.036	0.412
	(1.9)	(1.1)	(0.8)	(1.0)
TAX (−1)	−0.15**	−0.848	−0.026	−0.136
	(2.3)	(1.6)	(0.8)	(0.6)
LIQUIDITY (−1)	−0.074	−0.324	0.021	0.337
	(1.5)	(0.6)	(0.8)	(1.5)
LTD (−1)	1.157**	13.79*	−0.137*	−0.143
	(2.2)	(1.8)	(1.8)	(0.2)
LFX (−1)	0.02	0.287	−0.07	−0.416
	(0.3)	(0.3)	(1.5)	(1.0)
RR (−1)	0.016	0.0104	0.0088	0.093
	(1.1)	(0.1)	(1.3)	(1.2)
SIFI (−1)	0.093	0.611	0.015	−0.124
	(1.5)	(1.0)	(0.3)	(0.2)
OTHER (−1)	−0.061**	−0.64*	0.046**	0.207
	(2.0)	(1.9)	(2.1)	(0.9)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.2 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

the onset of the subprime crisis. Appendix Table A.2.5 shows that bank profitability by both measures was lower after the onset of the subprime crisis, while capital/assets was higher, probably due to the effect of Basel III measures. Banking competition was lower in the later period, as was recourse to non-deposit liabilities.

Looking first at the baseline regressions in Appendix Table A.3.3, a number of coefficients in both periods are similar to the global sample in Table 5, notably in respect of bank size, credit risk and competition as well as GDP growth. On the other hand, the effect of capitalisation on ROAE is much lower in the post-crisis period, which may reflect the effects of Basel III. Liquidity risk is only significant for both measures in the post-crisis period, and diversification also for the ROAE. The effects of banking crises on profitability are much lower in the post-2007 period, although the credit risk effects are greater.

Table 11
Summary macroprudential instruments results for retail and universal banks for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Retail and Consumer Banks		Universal Banks	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Summary macroprudential instruments				
MAPP-INDEX (−1)	−0.008	−0.096	0.0018	0.0042
	(1.1)	(1.3)	(0.4)	(0.1)
LOAN-TARGETED (−1)	−0.016	−0.12	0.012	0.03
	(1.2)	(0.8)	(1.5)	(0.4)
DEMAND (−1)	−0.035	−0.238	0.022**	0.198*
	(1.6)	(0.8)	(2.2)	(1.9)
SUPPLY-ALL (−1)	−0.001	−0.062	0.00019	−0.01
	(0.1)	(0.8)	(0.1)	(0.2)
SUPPLY-LOANS (−1)	0.00004	−0.031	0.0083	−0.096
	(0.1)	(0.1)	(0.6)	(0.7)
SUPPLY-GENERAL (−1)	0.0041	−0.023	0.0065	0.091
	(0.4)	(0.2)	(1.2)	(1.4)
SUPPLY-CAPITAL (−1)	−0.008	−0.182	−0.025*	−0.285**
	(0.4)	(1.0)	(1.8)	(2.2)

Note: The summary macroprudential instruments' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.2 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

Turning to the individual measures of macroprudential policy (Table 12), capital measures are significant and negative in both periods, albeit not for the ROAE, pre crisis. Provisioning requirements are also significant and negative pre- and post-crisis for both measures. Pre-crisis we have negative and significant effects for debt-service-to-income measures on the ROAA and leverage measures on the ROAE. Tax is also significant and negative post-crisis for both measures, and conservation for the ROAE. Positive effects on profitability are found pre-crisis for liquidity for the ROAA, and loan to deposit measures for the ROAE. Post-crisis, there is a positive effect for leverage measures on the ROAA and for reserve requirements on the ROAE, and a negative effect for conservation on the ROAE also. In terms of summary measures (Table 13), we find, as in the global sample, that it is only capital supply measures that are consistently significant and negative; other summary variables are not significant except for supply-general which is positive for the ROAE in the post-crisis period. We suggest that the contrasts between subsamples reflect the relative use and intensity of application of the different policies. Note that some policies were not applied pre-crisis (such as SIFI limits) and hence no results are available.

Table 14 below shows a summary of the results of the effects of macroprudential policy on banks' profitability for all countries, and for the three pairs of subsamples shown above. We can compare it with the results of the extant literature on the effectiveness of macroprudential policy in reducing financial system imbalances (Table 1), which shows that the most commonly significant variables for reducing credit growth are provisioning measures, limits of loan growth, limits on foreign currency lending, loan-to-value limits, debt-to-income limits and tax measures.

Comparing our own results with those in Table 1, we find that foreign currency lending limits, tax measures and, in some estimates, loan-loss provision measures may reduce lending, but this is at the cost

Table 12
Individual macroprudential instruments results for the periods 1990–2006 and 2007–2018 (estimated by panel OLS with bank-level and time fixed effects).

Period	1990–2006		2007–2018	
Coverage	Global sample		Global sample	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Individual macroprudential instruments				
CCB (−1)	na	na	0.062	0.65
			(1.1)	(1.3)
CONSERVATION (−1)	na	na	−0.004	−0.419**
			(0.2)	(2.2)
CAPITAL (−1)	−0.127*	−1.63	−0.048***	−0.418***
	(1.7)	(1.6)	(3.3)	(2.6)
LVR (−1)	−0.23	−6.34***	0.113**	0.431
	(0.9)	(2.8)	(2.1)	(0.7
LLP (−1)	−0.117*	−1.184*	−0.104*	−0.877*
	(2.0)	(1.9)	(2.0)	(1.6)
LCG (−1)	−0.146	−2.32	0.119	−0.402
	(0.5)	(1.0)	(1.3)	(0.5)
LOANR (−1)	0.274	1.0	0.0157	−0.067
	(1.3)	(0.6)	(0.8)	(0.4)
LFC (−1)	−0.033	−0.1	−0.128	−0.59
	(0.2)	(0.1)	(1.6)	(1.0)
LTV (−1)	0.041	−0.23	0.007	0.0085
	(0.5)	(0.3)	(0.4)	(0.1)
DSTI (−1)	−0.5**	−1.973	0.017	0.147
	(2.1)	(1.0)	(0.4)	(0.3)
TAX (−1)	−0.052	−1.892	−0.045*	−0.396*
	(0.2)	(0.5)	(1.7)	(1.9)
LIQUIDITY (−1)	0.218**	1.36	0.0049	0.215
	(2.3)	(0.9)	(0.2)	(1.1)
LTD (−1)	0.311	5.67**	−0.05	0.14
	(1.1)	(2.0)	(0.5)	(0.1)
LFX (−1)	0.077	−0.64	−0.021	−0.291
	(0.5)	(0.5)	(0.4)	(0.6)
RR (−1)	−0023	−0.223	0.0092	0.123*
	(1.0)	(0.8)	(0.9)	(1.7)
SIFI (−1)	na	na	0.023	0.18
			(0.6)	(0.4)
OTHER (−1)	−0.099	0.386	0.0063	−0.225
	(0.5)	(0.3)	(0.3)	(0.9)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.3 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. Na not applicable as the instrument has not been used over the estimation period. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

of bank profitability. On the other hand, limits on credit growth and loan measures reduce loan growth but tend to accompany rising profitability, perhaps because banks can substitute into non-interest income. Loan-to-value and debt-service-to-income measures, which are also potent in reducing overall credit growth, are not widely significant in affecting profitability, although for some subsamples loan-to-value boosts profitability, and debt-service-to-income reduces it. Finally, capital requirements have not been widely seen as reducing credit growth (although policies such as sectoral risk weights may have that intention) but have a clear negative effect on profitability. This underlines the fact that macroprudential policy seeks not only to reduce credit or asset price growth but also to enhance robustness, and capital does contribute to this (see, for example, Altunbas et al. (2018) and Davis et al. (2020b)).

Table 13
Summary macroprudential instruments results for the periods 1990–2006 and 2007–2018 (estimated by panel OLS with bank-level and time fixed effects).

Period	1990–2006		2007–2018	
Coverage	Global sample		Global sample	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Summary macroprudential instruments				
MAPP-INDEX (−1)	−0.015	−0.212	−0.0033	−0.043
	(0.8)	(1.0)	(0.6)	(1.0)
LOAN-TARGETED (−1)	−0.011	−0.315	0.0007	−0.051
	(0.4)	(1.0)	(0.1)	(0.9)
DEMAND (−1)	−0.042	−0.421	0.0067	0.025
	(0.8)	(0.7)	(0.6)	(0.2)
SUPPLY-ALL (−1)	−0.015	−0.235	−0.004	−0.044
	(0.6)	(0.9)	(0.7)	(0.8)
SUPPLY-LOANS (−1)	0.0174	−0.35	−0.0053	−0.168
	(0.3)	(0.5)	(0.4)	(1.2)
SUPPLY-GENERAL (−1)	−0.014	−0.176	0.0072	0.117**
	(0.6)	(0.7)	(1.0)	(2.0)
SUPPLY-CAPITAL (−1)	−0.15*	−2.6***	−0.0262**	−0.288**
	(1.7)	(2.6)	(2.2)	(2.2)

Note: The summary macroprudential instruments' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Appendix Table A.3.3 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

8. Variants

In light of the aggregate results above, we considered it helpful to run two variants on the work. The first is to test whether the effect of the macroprudential policies varies between banks depending on their size and their capitalisation. The second is to assess the short-run effects of the tightening and loosening of policies, in effect taking the first-difference of the cumulated data that we use in the rest of the paper. We note that this test will not capture the ongoing effects of a policy, but only the initial effects of its introduction or tightening. The baseline for these variants is the global estimate shown in Table 5.

8.1. Variant showing differing effects on banks by size and capital

The test for size and capitalisation effects involves looking at the coefficient on the policy variable alongside the same variable multiplied by size or capitalisation. We have demeaned the leveraged variables size (measured by the log of total assets) and capitalisation (measured by equity/assets), as in Altunbas et al. (2018), before multiplying by the macroprudential variable. Hence, equality of coefficients with opposite signs implies a zero effect of macroprudential policy at mean levels of size or capitalisation.

Looking first at the effect of bank size on the impact of policy (Table 15), we find a common pattern across a number of policies, namely that small banks face a decline in profitability when policy is more stringent, especially as measured by the ROAA. This is the case for credit growth limits, loan measures, loan-to-value ratios, debt-to-income ratios, tax, reserve ratios and other measures. Comparing the coefficients on policy and the leveraged variable, the effect becomes positive for banks larger than the mean in each case except tax, where it becomes positive for banks somewhat below the average size.

Table 14
Summary table of the results of the effects of macroprudential policy on banks' profitability.

	All countries (Tables 6 and 7)		Regional subsamples (Tables 8 and 9)				Segmented by bank type (Tables 10 and 11)				Pre- and post-crisis (Tables 12 and 13)			
Period	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2006	1990–2006	2007–2018	2007–2018
Coverage	Global	Global	EMDE	EMDE	Advanced	Advanced	Retail	Retail	Universal	Universal	Global	Global	Global	Global
Dependent variable	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE	ROAA	ROAE
CCB		+***	+***	+***					+*	+***				
CONSERVATION							+*							-**
CAPITAL	-***	-***	-***	-***					-**	-**	-*		-***	-***
LVR	+**		+*				+**					-***	+**	
LLP										-*	-*	-*	-*	
LCG	+*		+**				+*							
LOANR	+**		+***						+**					
LFC	-**	-*	-*						-**					
LTV			+**						+*					
DSTI							-*				-**			
TAX	-*				-**		-**						-*	-**
LIQUIDITY						+**					+**			
LTD							+**	+*	-*			+**		
LFX														
RR			+***	+*		-*								+*
SIFI														
OTHER			+*				-**	-*	+**					
MAPP-INDEX														
LOAN-TARGETED			+**											
DEMAND			+**	+**					+**	+*				
SUPPLY-ALL														
SUPPLY-LOANS			+*											
SUPPLY-GENERAL			+**											+**
SUPPLY-CAPITAL	-**	-**	-***	-***					-*	-**	-*	-***	-**	-**

Notes: Signs of significant variables are shown where those marked *** are significant at 1%, ** significant at 5% and * significant at 10%. A blank implies the variable was tested but not significant. EMDE stands for emerging market and developing economies. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Tables 2 and 3 for more detailed definitions of the instruments and summary measures.

Table 15
Individual macroprudential instruments results for all countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects) with leveraged coefficients on macroprudential policy.

	Leveraged by bank size				Leveraged by capital ratio			
Dependent variable	ROAA		ROAE		ROAA		ROAE	
Individual macroprudential instruments	MPP	MPP* SIZE	MPP	MPP* SIZE	MPP	MPP* CAP	MPP	MPP* CAP
CCB (−1)	−0.56	0.62	−5.2	6.03*	0.07	0.01	2.3**	−1.5**
	(1.4)	(1.5)	(1,5)	(1.7)	(0.6)	(0.1)	(2.3)	(2.1)
CONSERVATION (−1)	−0.01	0.03	2.96*	−2.75**	0.06*	−0.05*	−0.11	0.11
	(0.1)	(0.3)	(1.9)	(2.0)	(1.7)	(1.8)	(0.4)	(0.6)
CAPITAL (−1)	−0.16	0.11	1.84**	−2.12**	−0.03	−0.02	−0.68***	0.37***
	(1.5)	(1.1)	(2.0)	(2.3)	(1.3)	(1.3)	(4.0)	(3.6)
LVR (−1)	−0.4	0.46	7.34	−6.69*	0.25***	−0.19**	0.05	0.02
	(0.8)	(1.1)	(1.6)	(1.7)	(3.4)	(2.0)	(0.1)	(0.1)
LLP (−1)	−0.5	0.43	1.51	−1.96	−0.01	−0.05	−1.33**	1.04**
	(1.4)	(1.3)	(0.6)	(0.8)	(0.2)	(0.8)	(2.4)	(2.4)
LCG (−1)	−1.98**	2.0***	−3.72	3.09	0.16	−0.01	−0.27	−0.16
	(2.5)	(2.7)	(0.7)	(0.6)	(1.4)	(0.1)	(0.3)	(0.3)
LOANR (−1)	−0.43***	0.42***	−0.93	0.96	0.12***	−0.11***	0.05	0.14
	(3.5)	(4.2)	(0.8)	(0.9)	(5.3)	(4.4)	(0.3)	(0.7)
LFC (−1)	0.001	−0.11	5.0	−5.2	−0.13*	0.02	−1.9**	1.43
	(0.1)	(0.2)	(1.0)	(1.3)	(1.7)	(0.2)	(2.4)	(1.5)
LTV (−1)	−0.52***	0.48***	−1.78	1.73*	0.12***	−0.14***	−0.14	0.39*
	(4.0)	(4.4)	(1.5)	(1.8)	(3.8)	(3.8)	(0.5)	(1.7)
DSTI (−1)	−1.06***	0.99***	−6.35*	5.97*	0.07	−0.08	−0.71	1.05*
	(4.0)	(4.5)	(1.8)	(1.9)	(1.1)	(1.5)	(0.9)	(1.8)
TAX (−1)	−1.17***	1.4***	−4.96**	4.33**	0.06	−0.14***	−0.72**	0.44**
	(4.2)	(4.3)	(2.2)	(2.2)	(1.2)	(2.9)	(2.3)	(2.2)
LIQUIDITY (−1)	−0.11	0.11	−0.42	0.53	0.03	−0.04	0.05	0.1
	(0.8)	(0.8)	(0.3)	(0.4)	(0.9)	(1.4)	(0.2)	(0.6)
LTD (−1)	−1.27	1.17	6.89	5.93	0.46***	−0.49***	1.58	−0.89
	(0.8)	(0.8)	(0.5)	(0.5)	(3.2)	(3.9)	(1.1)	(1.1)
LFX (−1)	−0.16	0.09	7.9**	−7.97**	0.06	−0.13**	−0.89	0.57
	(0.5)	(0.3)	(2.4)	(2.5)	(0.9)	(2.0)	(1.4)	(1.3)
RR (−1)	−0.19***	0.18***	−0.67	0.68	0.03***	−0.03**	0.11	−0.04
	(5.1)	(3.5)	(1.1)	(1.3)	(3.0)	(2.3)	(1.4)	(0.6)
SIFI (−1)	−0.06	0.01	3.41*	−2.98*	0.1	−0.06	0.23	0.05
	(0.4)	(0.8)	(1.8)	(1.9)	(1.3)	(1.2)	(0.3)	(0.2)
OTHER (−1)	−0.89***	0.82***	−0.1	0.1	0.15***	−0.19***	−0.1	0.1
	(4.8)	(4.9)	(0.3)	(0.4)	(4.2)	(4.6)	(0.3)	(0.4)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables (alone and multiplied by demeaned size or leverage ratios) added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

For the ROAE, the pattern of declines in profitability for small banks is present for the debt-to-income measures and tax measures, with a ratio of coefficients suggesting that only banks with size well above the mean have a zero or positive effect. We also find some contrary results for the ROAE. The effects of conservation, leverage, capital requirements, forex position limits and SIFI measures is positive for small banks but negative for larger ones, as would be expected notably for SIFI measures since they apply to large banks. Small banks typically have higher capital ratios so may be less affected by tightening in capital regulations such as Basel III.

The pattern for summary measures (Table 16) shows much wider significance than for the unleveraged estimates cited above. In respect of size, all the summary measures for the ROAA show a benefit from size in terms of response to macroprudential policy, with the small banks being negatively affected and larger ones seeing a boost to profitability. This may reflect greater flexibility and scope to arbitrage on the part of larger banks. A similar pattern arises for loan-targeted and demand measures for the ROAE, with again larger banks seeing a benefit while small banks face a decline in profitability. The only contrary effect for size is in the case of supply-capital measures where large banks tend to face a lower ROAE when such measures are in force, while smaller ones may see a boost to profits.

As regards the results for varying levels of capitalisation, a common pattern for the ROAA is to find that the baseline effect is to boost profitability but this is negative for banks with higher capitalisation. This is the case for capital measures such as the conservation buffer and the leverage ratio as well as loan measures, loan-to-value limits, loan to deposit, reserve requirements and other measures. Meanwhile, tax measures and limits to FX positions reduce profitability in line with capitalisation, while foreign currency loan limits reduce ROAA regardless of capitalisation. We note that the correlation of capitalisation and the log of bank size is −0.41 (Table A.2.3), with small banks being more highly capitalised, so these results may also relate to bank size.

In respect of the ROAE, we find a similar pattern of greater negative impact on higher-capitalised banks for the countercyclical buffer. On the other hand, highly-capitalised banks are less affected than lower-capitalised ones by capital requirements, provisioning requirements and tax measures, according to this measure of profitability. Effects of foreign currency lending limits are negative and significant regardless of bank capitalisation. Loan-to-value and debt-service-to-income measures boost profitability more, according to the ROAE, in better capitalised banks. The summary measures all show that highly-capitalised banks tend to have a lower ROAA with the application of macroprudential measures but in several cases they may have a higher ROAE.

In sum, we have found that small banks bear more of the burden of macroprudential policy than large ones for a number of measures,

Table 16
Summary macroprudential instruments results for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects) with leveraged coefficients on macroprudential policy.

	Leveraged by bank size				Leveraged by capital ratio			
Dependent variable	ROAA		ROAE		ROAA		ROAE	
Summary macroprudential instruments	MPP	MPP* SIZE	MPP	MPP* SIZE	MPP	MPP* CAP	MPP	MPP* CAP
MAPP-INDEX (−1)	−0.11***	0.1***	−0.22	−0.18	0.014***	−0.02***	−0.047	0.049**
	(4.7)	(5.0)	(1.0)	(1.0)	(2.6)	(4.2)	(1.3)	(2.0)
LOAN-TARGETED (−1)	−0.26***	0.24***	−0.78*	0.7**	0.047***	−0.054***	−0.17*	0.25***
	(5.1)	(5.8)	(1.8)	(2.0)	(3.8)	(3.7)	(1.9)	(2.6)
DEMAND (−1)	−0.43***	0.4***	−1.8*	1.7**	0.08***	−0.089***	−0.19	0.38**
	(4.7)	(5.2)	(1.8)	(2.0)	(3.2)	(3.2)	(0.9)	(2.0)
SUPPLY-ALL (−1)	−0.11***	0.1***	−0.15	0.12	0.014**	−0.019***	−0.05	0.048
	(4.3)	(4.5)	(0.5)	(0.5)	(2.3)	(3.5)	(1.1)	(1.6)
SUPPLY-LOANS (−1)	−0.38***	0.35***	−0.56	0.45	0.058***	−0.062***	−0.31*	0.31**
	(4.0)	(4.5)	(0.6)	(0.6)	(3.1)	(2.7)	(1.7)	(2.0)
SUPPLY-GENERAL (−1)	−0.17***	0.16***	−0.46	0.48	0.03***	−0.033***	0.079	−0.011
	(3.5)	(3.8)	(0.8)	(1.0)	(3.3)	(3.3)	(1.1)	(0.2)
SUPPLY-CAPITAL (−1)	−0.13**	0.11*	1.1*	−1.3**	−0.003	−0.025*	−0.41***	0.23***
	(2.3)	(1.9)	(1.9)	(2.3)	(0.2)	(1.8)	(3.3)	(3.2)

Note: The summary macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables (alone and multiplied by demeaned size or leverage ratios) added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

including those found to affect aggregate credit growth. Banks with high capitalisation tend to suffer in terms of ROAA but benefit in terms of ROAE. Our results are consistent with Altunbas et al. (2018) who found that small banks also reacted more strongly to macroprudential policies in terms of risk reduction, but not in terms of capitalisation (where they found weakly capitalised banks reduced risk more). These results are more comprehensive than those for the unleveraged sample in Tables 6 and 7, showing the importance of considering how such affects can vary with size and capitalisation.

We suggest that these results are of considerable potential importance; there may be an undesirable structural effects of most measures of macroprudential policy, as they are shown to penalise small banks that could otherwise enhance overall levels of competition, as well as those that are adequately capitalised. Underlying such results may also be the greater scope for risk-shifting by large banks, possibility stimulated by moral hazard generated by the safety net of deposit insurance and lender of last resort for large banks, that lead them to consider themselves "too big to fail".

8.2. *Variant showing short-run effects of tightening and loosening*

Looking now at the effects of tightening and loosening of policy, we took one lag of each macroprudential policy change to allow the short-run effect to emerge.[24] Whereas in the full sample, a tightening has a one-off value of +1 and loosening of −1, in the separate series for tightening and loosening the change is in each case set at +1. Accordingly, what we expect is that there will be negative coefficients for tightening for a policy whose application depresses profitability, while a loosening should cause a recovery in profitability and hence there should be a positive sign. Note that we omit some policies (leverage and SIFI measures) since they have not seen loosening over the data period. Also, any differences with the cumulative results elsewhere in the paper do not imply a contradiction, since these results are only for the short term rather than ongoing effects of the policy, and they do not allow for the overall stringency of the policy. Note also the points made in Section 4 suggesting that cumulative measures of macroprudential policy are more appropriate than focus solely on changes in policy.

In the case of the ROAA (Table 17), we do find that tightening reduces profitability significantly in the short run for capital requirements, provisioning requirements and tax measures. Conversely, loan growth and liquidity measures show a boost to profits from tightening. As regards loosening, we find the expected pattern for removal of countercyclical buffers, limits on foreign currency lending and for other measures, with easing of the policy boosting profitability. On the other hand, profits decline with easing for capital requirements and tax measures. These may take place at times when profits are under pressure. For the ROAE, we find profits decline with a tightening of tax measures and limits on forex positions, while as for the ROAA, profits rise with introduction of credit growth limits. Easing of measures on capital, provisions, loan-to-value limits and tax measures entails lower profits in the short run, while easing of foreign currency lending limits raises profitability in line with the result for the ROAA.

Overall tightening of macroprudential policy as shown by the Mapp-Index measure (Table 18) reduces the ROAA significantly, as do loan-targeted measures and the supply-loans aggregate. Easing of supply-capital measures reduces profitability according to both the ROAA and the ROAE. In the case of the ROAE, there are no significant measures for tightening, while easing of overall policy (Mapp-Index), loan-targeted measures and supply-capital measures as noted accompany lower profitability in the short run.

On balance, we find that tightening measures do tend to reduce profitability while loosening do not necessarily raise it. Our results are consistent with Kuttner and Shim (2016) who found a greater effect of macroprudential tightening than of loosening.

Table 19 below shows a summary of the results of the variants.

9. Robustness checks

We undertook three further robustness checks on the sample, firstly with additional variables capturing the quality of microprudential supervision, secondly with bank-clustered standard errors and country and time fixed effects, and finally entering all the macroprudential policies together rather than one-by-one. Note that, as pointed out by Meuleman and Vander Vennet (2020), the subsamples and variants in Sections 7 and 8 also provide tests of the robustness of our approach.

[24] Similarly in Alam et al. (2019), a four-quarter lag was incorporated.

Table 17
Individual macroprudential instruments results for all countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects) with significant estimates for tightening (T) and loosening (L) of macroprudential policy.

Dependent variable	ROAA		ROAE	
Individual macroprudential instruments	Tightening (t-1)	Loosening (t-1)	Tightening (t-1)	Loosening (t-1)
CCB	0.018	0.086*	0.417	−0.269
	(0.3)	(1.8)	(0.6)	(0.4)
CONSERVATION	0.038	0.045	0.445	0.61
	(0.7)	(0.5)	(1.0)	(0.5)
CAPITAL	−0.057**	−0.348**	−0.292	−3.85***
	(2.5)	(2.5)	(1.0)	(2.9)
LVR	0.091	0.015	0.766	−0.656
	(1.0)	(0.1)	(0.9)	(0.6)
LLP	−0.16**	−0.122	−1.023	−2.288***
	(2.0)	(1.4)	(1.6)	(2.9)
LCG	0.135*	0.239	1.91*	2.4
	(1.8)	(1.0)	(1.7)	(1.5)
LOANR	−0.052	−0.026	−0.46 (1.0)	−0.367
	(1.4)	(0.5)		(0.2)
LFC	0.027	0.328***	−0.836	3.096*
	(0.22)	(3.0)	(0.7)	(1.7)
LTV	−0.015	−0.121	0.095	−1.83*
	(0.6)	(1.6)	(0.3)	(1.9)
DSTI	−0.029	−0.138	−0.35	−2.56
	(0.7)	(0.5)	(0.8)	(0.7)
TAX	−0.079**	−0.511***	−0.86***	−2.91***
	(2.1)	(3.3)	(2.9)	(3.3)
LIQUIDITY	0.056*	−0.094	0.51	−1.67
	(1.7)	(0.6)	(1.4)	(1.6)
LTD	−0.265	−0.065	−4.54	−1.39
	(1.1)	(0.5)	(1.5)	(1.3)
LFX	−0.094	0.004	−1.36**	−0.646
	(1.2)	(0.1)	(2.1)	(0.4)
RR	−0.025	−0.015	−0.055	−0.056
	(1.1)	(0.4)	(0.3)	(0.2)
OT	0.039	0.084*	0.119	0.254
	(0.7)	(1.7)	(0.3)	(0.5)

Note: The macroprudential instruments' coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables for both tightening and loosening added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. See Table 2 for more detailed definitions of the instruments.

The additional supervision variables are summary measures for activity restrictions, capital requirement stringency and supervisory power from the series of World Bank surveys of bank regulation and supervision around the world (Barth et al., 2013) updated using the latest survey for 2016 (Anginer et al., 2019).[25] These data were also used in papers such as Karolyi and Tabaoda (2015), Gaganis et al. (2020) and Danisman and Demirel (2019). We note that the surveys themselves are for the individual years 1999, 2003, 2007, 2011 and 2016. To cover the sample with annual observations, we have interpolated between the values given in the surveys and fixed the values of 1999 for 1990–8 and 2016 for 2017–18. Karolyi and Tabaoda (2015) similarly fixed their values for 2012–2015 at the 2011 level.

[25] We obtained the summary references for the first four surveys from Barth et al. (2013) and the authors' dataset (http://faculty.haas.berkeley.edu/ross_levine/Papers/Copy%20of%20BCL_Sup_Reg_Data_13JAN2013.xls). Estimates for the summary indices for 2016 were calculated by the authors using the methods for 2011 set out in the Barth et al. dataset (for supervisory power), advice from the World Bank (for capital) and data from the World Bank (for activity restrictions). We thank Asli Demirgüç-Kunt and Davide Salvatore Mare for their help and advice.

Table 18
Individual macroprudential instruments results for all countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects) with significant estimates for tightening (T) and loosening (L) of macroprudential policy.

Dependent variable	ROAA		ROAE	
Summary macroprudential instruments	Tightening (t-1)	Loosening (t-1)	Tightening (t-1)	Loosening (t-1)
MAPP-INDEX (−1)	−0.018*	−0.0404	−0.101	−0.47*
	(1.7)	(1.3)	(0.9)	(1.7)
LOAN-TARGETED (−1)	−0.032**	−0.052	−0.262	−0.943*
	(2.3)	(1.2)	(1.4)	(1.7)
DEMAND (−1)	−0.016	−0.099	−0.06	−1.574
	(1.0)	(1.2)	(0.3)	(1.5)
SUPPLY-ALL (−1)	−0.023	−0.03	−0.116	−0.343
	(1.6)	(0.9)	(0.7)	(1.2)
SUPPLY-LOANS (−1)	−0.067**	−0.002	−0.62	−0.48
	(2.1)	(0.1)	(1.5)	(0.9)
SUPPLY-GENERAL (−1)	−0.021	−0.019	−0.069	−0.15
	(1.0)	(0.5)	(0.5)	(0.4)
SUPPLY-CAPITAL (−1)	−0.013	−0.184*	0.072	−2.24**
	(0.6)	(1.8)	(0.3)	(2.3)

Note: The summary macroprudential instruments coefficient values are reported and the t-statistics are reported in parenthesis below each estimated coefficient. Each equation includes all the control variables shown in Table 5 and is estimated by panel OLS with bank and time fixed effects, with macroprudential variables for both tightening and loosening added one at a time. *** significant at 1%, ** significant at 5%, * significant at 10%. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Table 3 for more detailed definitions of the summary measures.

The baseline estimate (Online Appendix Table OA.1.1) shows that the activity restrictions variable is significant for both ROAA and ROAE, while capital stringency and supervisory power are not. This is similar to Gaganis et al. (2020) who found activity restrictions to be significant for reducing risk, while capital stringency was not. The other coefficients are close to those in the baseline. We note that the number of observations is lower than in Table 5, given the supervision variables do not cover all countries and time periods. Results for macroprudential policies (Online Appendix Tables OA.1.2 and OA.1.3) are largely in line with the baseline in Tables 6 and 7, with capital requirements and foreign currency lending limits negative for both measures of profitability, while tax measures are also negative for the ROAA. Other parallels with the baseline are the positive effect of leverage measures on the ROAA and the countercyclical buffer on the ROAE. Some additional effects emerge such as a negative effect from limits to foreign currency positions on both measures of profitability and positive effects on the ROAA of the countercyclical buffer, the conservation buffer, the SIFI buffer and other measures. These may reflect the slightly different sample. Again, as in the baseline, the summary variable for capital-supply is the only one found to be significant.

We went on to estimate the ROAA and ROAE models using robust standard errors clustered at a bank-level and country and time fixed effects. Banks are exposed to different country risks (e.g. regulations and laws) and operate in different financial-system structures and institutions and are at different stages of development. Therefore, we

Table 19
Summary table of the results of the variants.

	Leveraged coefficients by bank size (Tables 15 and 16)				Leveraged coefficients by unadjusted capital adequacy (Tables 15 and 16)				Policy tightening and loosening (Tables 17 and 18)			
Period	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018
Coverage	Global	Global	Global	Global	Global	Global	Global	Global	Global Tighten	Global Loosen	Global Tighten	Global Loosen
Dependent variable	ROAA	ROAA*SIZE	ROAE	ROAE*SIZE	ROAA	ROAA*CAP	ROAE	ROAE*CAP	ROAA	ROAA	ROAE	ROAE
CCB				+*			+**	-**		+*		
CONSERVATION			+*	-**	+**	-*						
CAPITAL			+**	-**			-***	+***	-**	-**		-***
LVR				-*	+**	-**						
LLP							-**	+**	-**			-***
LCG	-**	+***							+*		+*	
LOANR	-***	+***			+***	-***						
LFC					-*		-**			+***	-***	-***
LTV	-***	+***		+*	+***	-***		+*				-*
DSTI	-***	+***	-*	+**				+*				
TAX	-***		-**	+**		-***	-**	+**	-**	-***	-*	-***
LIQUIDITY									+*			
LTD					+***	-***						
LFX			+**	-**		-**					-**	
RR	-***	+**			+***	-**						
SIFI			+*	-*								
OTHER	-***	+***			+***	-***				-*		
MAPP-INDEX	-***	+***			+***	-***		+**	-*			-*
LOAN-TARGETED	-***	+***	-*	+**	+***	-***	-*	+***	-**			-*
DEMAND	-***	+***	-*	+**	+***	-***		+**				
SUPPLY-ALL	-***	+***			+**	-***						
SUPPLY-LOANS	-***	+***			+***	-***	-*	+**	-**			
SUPPLY-GENERAL	-***	+***			+***	-***						
SUPPLY-CAPITAL	-**	+*	+*	-**		-*	-***	+***		-*		-**

Notes: Signs of significant variables are shown where those marked *** are significant at 1%, ** significant at 5% and * significant at 10%. A blank implies the variable was tested but not significant. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Tables 2 and 3 for more detailed definitions of the instruments and summary measures.

assess whether controlling for country characteristics by country dummies can affect the empirical results, while clustering at a bank level. This is an established approach in the literature as in Mirzaei et al. (2013), Alessandri and Nelson (2015) and Anginer, Demirgüç-Kunt, and Mare (2018). We contend that bank-level clustering may be of particular relevance given the results above showing that the impact of macroprudential policy is strongly affected by characteristics of individual institutions.

The model results (see Online Appendix Table OA.1.4) show that banks' profitability (both ROAA and ROAE) are determined as in the baseline for most of the control variables. Differences are that bank size is now insignificant for the ROAA, while diversification is significant and positive for both ROAA and ROAE, as is inflation for ROAE with a positive sign.

In terms of the macroprudential instruments, Online Appendix Tables OA.1.5 and OA.1.6 show that there are negative effects from both measures for capital requirements and tax measures, as in the main results in Table 6. For the ROAA there are also negative effects from debt-service-to-income measures and for SIFI capital rules. In the case of the ROAE there are a wider range of negative effects than in the baseline, including conservation, the leverage ratio, provisions and measures to control credit and loan growth. These suggest that country as well as bank characteristics can affect the results, while the main effects remain as in the baseline. As regards the summary results, we find that supply-capital is highly significant and negative, as in the baseline, but also there is a negative effect of all measures (MAPP-index) and supply-all indices for both measures, and also loan-targeted and supply-loans for the ROAE.

Finally, in line with the bulk of the existing literature, we have carried out all the tests of macroprudential policy one variable at a time. However, we note that some recent papers such as Altunbas et al. (2018) have introduced policies all together. Accordingly, a third and final robustness check was to enter all the individual policies together, to see whether it is consistent with the one-by-one approach. The results, as shown in Online Appendix Table A.1.7, are consistent with the baseline results in Tables 5 and 6, with negative effects for capital requirements, foreign currency loan restrictions and tax measures. There are also positive effects for loan measures in ROAA and countercyclical buffers in ROAE as in Table 6. We do not run this test for the summary indices since there are considerable overlaps between the summary variables.

Overall, we contend that the results for variants and robustness underpin the validity of the main results of the paper. They are summarised in Table 20 below.

10. Conclusions

The purpose of this article is to present estimates of effects of macroprudential policies on banks' profitability in the context of appropriate control variables, which will also help in the understanding of how banks react to macroprudential regulations. To our knowledge, this analysis has not been undertaken in the research literature to date. The empirical results suggest that in the sample period 1990–2018, a number of measures of macroprudential policy such as capital requirements, limits on foreign currency lending and taxation measures, and in some estimates loan-loss provision measures, had a negative and significant effect on banks' profitability as measured by return of average assets (ROAA) and return on average equity (ROAE). Other measures such as limits on credit growth and loan measures tend, on the other hand, to boost the ROAA.

Table 20
Summary table of the results of the robustness checks.

	With supervision variables (Online Appendix Tables OA.1.2 and OA.1.3)		Bank-clustered standard errors, country and time dummies (Online Appendix Tables OA.1.5 and OA.1.6)		All MPP variables (Online Appendix Table OA.1.7)	
Period	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018	1990–2018
Coverage	Global	Global	Global	Global	Global	Global
Dependent variable	ROAE	ROAA	ROAA	ROAE	ROAA	ROAE
CCB	+*	+***				+*
CONSERVATION	+**			-**		
CAPITAL	-***	-***	-***	-***	-***	-***
LVR	+*			-**		
LLP				-**		
LCG				-***		
LOANR				-***	+***	
LFC	-***	-***			-*	-**
LTV						
DSTI			-*			
TAX	-**		-***	-**	-***	-*
LIQUIDITY						
LTD						
LFX	-**	-***				
RR						
SIFI	+***		+*			
OTHER	+**					
MAPP-INDEX			-**	-***	Na	Na
LOAN-TARGETED				-*	Na	Na
DEMAND					Na	Na
SUPPLY-ALL			-**	-***	Na	Na
SUPPLY-LOANS				-***	Na	Na
SUPPLY-GENERAL					Na	Na
SUPPLY-CAPITAL	-**	-*	-***	-***	Na	Na

Notes: *** significant at 1%, ** significant at 5%, * significant at 10%. Na – not applicable. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Tables 2 and 3 for more detailed definitions of instruments and summary measures.

We also find that country-development, bank types and time periods influence the effect of macroprudential policy on banks' profitability. The results show that, although some macroprudential instruments are significant and negatively affect banks' profitability quite consistently, factors such as country-development and bank characteristics can influence which macroprudential instrument have the greater impact on banks' profitability. Similar differences were found in papers assessing effects on credit such as Cerutti et al. (2017) and Davis et al. (2017). Authorities should thus be aware that there is no "one size fits all" and careful consideration of country and bank characteristics is needed in choice of instrument.

We also found that small banks bear more of the burden of macroprudential policy than large ones for a number of measures, including those found to affect aggregate credit growth. Banks with high capitalisation tend to suffer in terms of ROAA but benefit in terms of ROAE. We suggest that this is an important result since it means that there could be an undesirable structural effect of macroprudential policy, penalising small banks that could otherwise enhance overall levels of competition, as well as those that may already meet desirable levels of capitalisation. Short-run effects of tightening and loosening are also found for a number of policies; whereas tightening is mostly found to reduce profitability, there are several policies where loosening accompanies lower rather than higher profitability. Our overall results are broadly underpinned by three robustness checks.

In line with our hypotheses set out in Section 2, our empirical results suggest that some of the measures which research has shown to reduce financial imbalances also reduce banks' profitability. These include foreign currency lending limits, tax measures and in some estimates loan-loss provision measures. Capital requirements also affect profitability negatively but not credit growth in most extant studies (albeit being effective in increasing robustness and reducing risk). However, we found a further subset of measures such as limits on credit growth, loan measures, loan-to-value measures and debt-service-to-income limits that do not affect or may boost profitability, but do limit credit growth.

These results are of policy relevance, since they suggest there is a varying efficiency of macroprudential measures. The most efficient limit credit without hitting bank profitability, and hence they allow banks to build up capital and develop robustness while having the desired effect on credit conditions at a macro level. Our work suggests that a second group affect credit but reduce bank profits at the same time. Such a "cost of regulation" effect may be counterproductive if banks seek to offset lower profitability by taking higher risk. Even if this is not the case, lower profits will limit scope to build up capital buffers from retained earnings. A third group reduces bank profits but has no detectable effect on credit at a macro level, although they may increase robustness. On the other hand, these results for average effects must be considered alongside the differential effects of many policies on banks depending on size and capitalisation. This overall pattern is worthy of further research, especially at a country level, before policy measures are introduced.

Further research could also be undertaken to analyse the impact macroprudential policy has on the real economy when banks' profits are restricted. The contrasting results for the country and bank type are worthy of further investigation by regions and individual countries for the benefit of regulators. Detailed country characteristics could be considered for testing. In addition, research can be undertaken to understand the monetary and macroprudential policy nexus in terms of how banks' deposit and lending rates (and hence the net interest margin) react to the employment of macroprudential policy and whether there are offsetting effects in non-interest income. Finally, there could be investigation into whether there is a nonlinear relation of profitability to bank size.

CRediT authorship contribution statement

E. Philip Davis: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing - original draft; Writing - review & editing. **Dilruba Karim**: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing - original draft; Writing - review & editing. **Dilruba Karim**: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing - original draft; Writing - review & editing.

Appendix A. Countries and banks used in the empirical analysis

Table A.1.1
List of countries and number of banks.

Country	ISO Code	IMF category	Region	No. of banks	
				Advanced countries	Emerging market and developing economies
Algeria	DZA	EMDE	Africa		16
Angola	AGO	EMDE	Africa		25
Argentina	ARG	EMDE	South America		87
Australia	AUS	ADV	Oceania	154	
Austria	AUT	ADV	Europe	160	
Bahamas	BHS	EMDE	Caribbean		57
Bahrain	BHR	EMDE	Middle East		43
Barbados	BRB	EMDE	Caribbean		9
Belgium	BEL	ADV	Europe	129	
Belize	BLZ	EMDE	Caribbean		5
Bolivia	BOL	EMDE	South America		24
Brazil	BRA	EMDE	South America		188
Bulgaria	BGR	EMDE	Europe		36
Canada	CAN	ADV	North America	137	
Chile	CHL	EMDE	South America		51
China	CHN	EMDE	Asia		129
Colombia	COL	EMDE	South America		87
Costa Rica	CRI	EMDE	Central America		92
Cote D'Ivoire	CIV	EMDE	Africa		22

(continued on next page)

Table A.1.1 (*continued*)

Country	ISO Code	IMF category	Region	No. of banks	
				Advanced countries	Emerging market and developing economies
Croatia	HRV	EMDE	Europe		82
Cyprus	CYP	ADV	Europe	35	
Czech Republic	CZE	ADV	Europe	66	
Denmark	DNK	ADV	Europe	130	
Ecuador	ECU	EMDE	South America		64
Egypt	EGY	EMDE	Africa		37
El Salvador	SLV	EMDE	Central America		37
Estonia	EST	ADV	Europe	19	
Finland	FIN	ADV	Europe	89	
France	FRA	ADV	Europe	171	
Germany	DEU	ADV	Europe	156	
Ghana	GHA	EMDE	Africa		47
Greece	GRC	ADV	Europe	37	
Guatemala	GTM	EMDE	Central America		53
Guyana	GUY	EMDE	Caribbean		7
Honduras	HND	EMDE	Central America		35
Hong Kong	HKG	ADV	Asia	129	
Hungary	HUN	EMDE	Europe		119
Iceland	ISL	ADV	Europe	47	
India	IND	EMDE	Asia		127
Indonesia	IDN	EMDE	Asia		166
Ireland	IRL	ADV	Europe	93	
Israel	ISR	ADV	Europe	24	
Italy	ITA	ADV	Europe	177	
Jamaica	JAM	EMDE	Caribbean		16
Japan	JPN	ADV	Asia	158	
Jordan	JOR	EMDE	Middle East		19
Kenya	KEN	EMDE	Africa		73
Korea	KOR	ADV	Asia	142	
Kuwait	KWT	EMDE	Middle East		27
Latvia	LVA	ADV	Europe	34	
Lithuania	LTU	ADV	Europe	17	
Luxembourg	LUX	ADV	Europe	172	
Malaysia	MYS	EMDE	Asia		97
Malta	MLT	ADV	Europe	27	
Mexico	MEX	EMDE	Central America		109
Mongolia	MNG	EMDE	Asia		13
Morocco	MAR	EMDE	Africa		34
Mozambique	MOZ	EMDE	Africa		19
Netherlands	NLD	ADV	Europe	91	
New Zealand	NZL	ADV	Oceania	45	
Nicaragua	NIC	EMDE	Central America		21
Nigeria	NGA	EMDE	Africa		103
Norway	NOR	ADV	Europe	142	
Oman	OMN	EMDE	Middle East		17
Panama	PAN	EMDE	Central America		111
Paraguay	PRY	EMDE	South America		49
Peru	PER	EMDE	South America		46
Philippines	PHL	EMDE	Asia		98
Poland	POL	EMDE	Europe		138
Portugal	PRT	ADV	Europe	131	
Qatar	QAT	EMDE	Middle East		14
Romania	ROM	EMDE	Europe		50
Russia	RUS	EMDE	Europe		187
Saudi Arabia	SAU	EMDE	Middle East		20
Serbia	SRB	EMDE	Europe		57
Singapore	SGP	ADV	Asia	57	
Slovak Republic	SVK	ADV	Europe	37	
Slovenia	SVN	ADV	Europe	40	
South Africa	ZAF	EMDE	Africa		67
Spain	ESP	ADV	Europe	200	
Suriname	SUR	EMDE	Caribbean		4
Sweden	SWE	ADV	Europe	132	
Switzerland	CHE	ADV	Europe	181	
Tanzania	TZA	EMDE	Africa		50
Thailand	THA	EMDE	Asia		58
Trinidad and Tobago	TTO	EMDE	Caribbean		21
Turkey	TUR	EMDE	Europe		130
UK	GBR	ADV	Europe	196	
Ukraine	UKR	EMDE	Europe		133
United Arab Emirates	ARE	EMDE	Middle East		41
Uruguay	URY	EMDE	South America		60
USA	USA	ADV	North America	168	
Total	92			3723	3527

Data sources: Fitch-Connect and IMF. Note: ADV – Advanced countries, EMDE – Emerging market and developing economies.

Appendix B. Descriptive statistics of the ROAA and ROAE baseline model variables

Table A.2.1
Cumulated variables for IMAPP integrated Macroprudential Policy Database; descriptive statistics for the period 1990–2018 (all countries).

Cumulated variables	Mean	Median	Maximum	Minimum	Standard. Deviation	Observations
CCB	0.019	0.000	3.000	−1.000	0.225	201,695
CONSERVATION	0.176	0.000	5.000	−1.000	0.595	201,695
CAPITAL	0.509	0.000	13.583	−3.000	1.239	201,695
LVR	0.078	0.000	3.000	0.000	0.316	201,695
LLP	0.196	0.000	5.000	−1.000	0.707	201,695
LCG	0.016	0.000	2.000	−1.000	0.202	201,695
LOANR	0.269	0.000	10.000	−3.000	0.975	201,695
LFC	0.106	0.000	5.000	−1.000	0.532	201,695
LTV	0.331	0.000	9.833	−3.000	1.158	201,695
DSTI	0.187	0.000	4.833	−1.000	0.626	201,695
TAX	0.114	0.000	6.000	−1.000	0.620	201,695
LIQUIDITY	0.167	0.000	9.750	−5.000	1.427	201,695
LTD	0.009	0.000	1.833	−2.000	0.148	201,695
LFX	0.162	0.000	4.250	−2.000	0.546	201,695
RR	−0.388	0.000	26.000	−11.750	3.256	201,695
SIFI	0.128	0.000	4.000	0.000	0.478	201,695
OT	0.250	0.000	6.000	−1.000	0.667	201,695
MAPP-INDEX	2.331	0.000	65.667	−10.667	7.229	201,695
LOAN-TARGETED	1.115	0.000	22.667	−6.000	2.896	201,695
DEMAND	0.519	0.000	11.000	−3.000	1.632	201,695
SUPPLY-ALL	1.320	0.000	51.000	−10.667	5.541	201,695
SUPPLY-LOANS	0.596	0.000	12.000	−3.000	1.590	201,695
SUPPLY-GENERAL	−0.059	0.000	30.000	−10.667	3.643	201,695
SUPPLY-CAPITAL	0.783	0.000	17.583	−3.000	1.777	201,695

Data Source: IMF (2020), cumulated over time and annualised. CCB is the countercyclical capital buffer, CONSERVATION the capital conservation buffer, CAPITAL capital requirements, LVR leverage ratio limits, LLP loan-loss provision measures, LCG limits to credit growth, LOANR loan restrictions, LFC foreign currency lending limits, LTV limits to the loan-to-value ratio, DSTI limits to the debt-service-to-income ratio, TAX tax measures, LIQUIDITY liquidity measures, LTD loan to deposit limits, LFX limits on FX positions, RR reserve requirements, SIFI measures on systemic institutions, OTHER measures not captured otherwise. MAPP-INDEX is the sum of dummies for all of 17 categories. The LOAN-TARGETED group consists of the "Demand" and the "Supply-loans" instruments. DEMAND comprises LTV and DSTI. SUPPLY-ALL comprises all categories other than LTV and DSTI. SUPPLY-LOANS is loan growth limits, provision measures, loan measures, limits to the loan to deposit ratio, and limits to foreign currency loans. SUPPLY-GENERAL is reserve requirements, liquidity requirements, and limits to FX positions. SUPPLY-CAPITAL is leverage, countercyclical buffers, conservation buffers, and capital requirements. See Tables 2 and 3 for more detailed definitions of the instruments and summary measures.

Table A.2.2
ROAA and ROAE baseline model variables; descriptive statistics for the period 1990–2018 (all countries).

Variables	Mean	Median	Maximum	Minimum	Standard Deviation	Observations
ROAA (%)	0.928	0.720	10.780	−10.372	2.352	88,833
ROAE (%)	8.552	8.390	61.270	−80.923	17.036	88,125
LNSIZE (log)	21.209	21.143	27.117	16.054	2.307	97,120
LEVERAGE	0.132	0.090	0.900	0.002	0.147	96,861
CREDRISK	0.065	0.030	0.633	0.000	0.101	53,007
LIQRISK	0.659	0.735	0.992	0.001	0.277	88,992
COSTINC (%)	63.733	61.330	241.794	0.706	31.908	96,910
DIVSIF	0.208	0.159	0.984	−0.192	0.210	93,565
LERNER	0.212	0.221	0.645	−0.962	0.209	78,440
BCRISIS	0.105	0.000	1.000	0.000	0.306	210,250
RGDPG (%)	3.091	3.070	11.467	−8.669	3.377	208,105
INFLAT (%)	11.296	3.004	376.746	−0.923	42.012	206,517

Data Sources: Fitch-Connect, World Bank, Laeven and Valencia (2018) and authors' calculations. ROAA is the return on average assets, ROAE is the return on average equity, LNSIZE is the log of total assets, LEVERAGE is unadjusted capital adequacy (equity/assets), CREDRISK is credit risk (non-performing loans/gross Loans), LIQRISK is liquidity/contractual risk (deposits/total liabilities), COSTINC is management efficiency (cost/income ratio), DIVERSIF is diversification (the share of non-interest income in gross revenue), LERNER is the Lerner Index as a measure of competition, BCRISIS is a dummy for banking crisis, RGDPG is the real economic growth rate in terms of GDP and INFLAT CPI Inflation. For more details, see Table 4. The variables other than BCRISIS are winsorised at 99% and in level (not lagged).

Table A.2.3
Correlation matrix for the return on average assets (ROAA) for the period 1990–2018 (all countries).

	ROAA	LNSIZE	LEVERAGE	CREDRISK	LIQRISK	COSTINC	DIVSIF	LERNER	BCRISIS	RGDPG	INFLAT
ROAA	1.000										
LNSIZE	−0.025	1.000									
LEVERAGE	0.243	−0.411	1.000								
CREDRISK	−0.279	−0.215	0.138	1.000							
LIQRISK	0.028	−0.192	−0.046	−0.043	1.000						
COSTINC	−0.456	−0.217	0.005	0.164	0.043	1.000					

(continued on next page)

Table A.2.3 (*continued*)

	ROAA	LNSIZE	LEVERAGE	CREDRISK	LIQRISK	COSTINC	DIVSIF	LERNER	BCRISIS	RGDPG	INFLAT
DIVSIF	0.015	0.054	0.009	0.064	−0.118	0.091	1.000				
LERNER	0.568	0.135	0.098	−0.191	0.104	−0.674	−0.087	1.000			
BCRISIS	−0.138	0.065	−0.062	0.075	−0.086	0.042	0.005	−0.106	1.000		
RGDPG	0.195	−0.084	0.069	−0.081	0.122	−0.090	−0.030	0.100	−0.324	1.000	
INFLAT	0.080	−0.203	0.091	0.115	−0.027	0.027	0.026	−0.073	0.068	0.021	1.000

Data Source: Fitch-Connect, World Bank, Laeven and Valencia (2018) and authors' calculations. The variables other than BCRISIS are winsorised at 99% and in level (not lagged). For variable definitions see Table A.2.2 above.

Table A.2.4
Correlation matrix for the return on average equity (ROAE) the period 1990–2018 (all countries).

	ROAE	LNSIZE	LEVERAGE	CREDRISK	LIQRISK	COSTINC	DIVSIF	LERNER	BCRISIS	RGDPG	INFLAT
ROAE	1.000										
LNSIZE	0.084	1.000									
LEVERAGE	0.001	−0.422	1.000								
CREDRISK	−0.316	−0.202	0.167	1.000							
LIQRISK	0.036	−0.198	−0.050	−0.032	1.000						
COSTINC	−0.481	−0.223	0.007	0.173	0.045	1.000					
DIVSIF	0.022	0.055	0.010	0.066	−0.118	0.085	1.000				
LERNER	0.490	0.123	0.086	−0.149	0.098	−0.714	−0.092	1.000			
BCRISIS	−0.154	0.072	−0.057	0.056	−0.083	0.041	0.005	−0.092	1.000		
RGDPG	0.227	−0.086	0.068	−0.080	0.121	−0.092	−0.029	0.098	−0.324	1.000	
INFLAT	0.075	−0.200	0.100	0.091	−0.021	0.027	0.021	−0.059	0.057	0.030	1.000

Data Source: Fitch-Connect, World Bank, Laeven and Valencia (2018) and authors' calculations. The variables other than BCRISIS are winsorised at 99% and in level (not lagged). For variable definitions see Table A.2.2 above. The correlations for variables other than the ROAE differ from Table A.2.3 since there are slightly less observations for the ROAE than the ROAA.

Table A.2.5
Baseline model variables, means for subsamples.

Subsample	Advanced countries	Emerging market and developing economies	Retail and consumer banks	Universal commercial banks	1990–2006, Global sample	2007–2018, Global sample
ROAA (%)	0.65	1.31	0.86	0.95	0.998	0.859
ROAE (%)	7.11	10.5	7.9	8.9	9.98	7.14
LNSIZE (log)	21.8	20.4	21.2	21.2	20.9	21.5
LEVERAGE	0.109	0.161	0.124	0.134	0.12	0.144
CREDRISK	0.046	0.085	0.052	0.072	0.068	0.063
LIQRISK	0.58	0.60	0.61	0.58	0.559	0.614
COSTINC (%)	63.7	63.8	62.8	64.4	63.3	64.2
DIVSIF	0.325	0.337	0.279	0.356	0.33	0.33
LERNER	0.206	0.219	0.218	0.209	0.193	0.23
BCRISIS	0.113	0.096	0.099	0.096	0.094	0.119
RGDPG (%)	2.46	3.78	2.47	3.28	3.39	2.67
INFLAT (%)	3.06	20.43	3.14	8.03	16.87	3.62

Data Source: Fitch-Connect, World Bank, Laeven and Valencia (2018) and authors' calculations. The variables other than BCRISIS are winsorised at 99% and in level (not lagged). For variable definitions see Table A.2.2 above.

Appendix C. Subsample baseline results

Table A.3.1
Regression results for return on average assets (ROAA) and return on average equity (ROAE) for emerging market and developing economies and advanced countries for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Advanced countries		Emerging market and developing economies	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Constant	3.87***	46.0***	7.0***	59.8***
	(4.4)	(4.4)	(5.4)	(5.5)
LNSIZE(−1)	−0.162***	−1.75***	−0.309***	−2.36***
	(4.8)	(3.9)	(5.5)	(4.9)
LEVERAGE(−1)	0.688 (1.1)	−13.77*** (3.2)	1.8** (2.6)	−17.15*** (3.7)
CREDRISK(−1)	−3.55***	−37.37***	−2.374***	−21.88***
	(8.0)	(8.3)	(5.9)	(6.9)
LIQRISK(−1)	0.344***	3.66***	0.425**	5.22***
	(2.6)	(2.3)	(2.3)	(4.0)

(*continued on next page*)

Table A.3.1 (*continued*)

Coverage	Advanced countries		Emerging market and developing economies	
Dependent variable	ROAA	ROAE	ROAA	ROAE
COSTINC(−1)	−0.00453***	−0.0623***	−0.00887***	−0.0806***
	(3.6)	(4.9)	(5.7)	(5.6)
DIVSIF(−1)	−0.188*	−1.8*	0.295*	1.898*
	(1.8)	(1.8)	(1.9)	(1.7)
LERNER(−1)	1.46***	10.75***	2.143***	11.47***
	(10.3)	(7.3)	(8.0)	(5.5)
BCRISIS	−0.204***	−3.8***	−0.655***	−5.418***
	(3.2)	(4.2)	(3.7)	(3.5)
RGDPG	0.0973***	1.126***	0.0829***	0.616***
	(6.9)	(6.4)	(4.7)	(5.5)
INFLAT	0.039***	0.45***	−0.0043	−0.034
	(2.6)	(2.6)	(0.8)	(0.8)
R-squared	0.5	0.46	0.53	0.48
R-squared (adj.)	0.45	0.39	0.47	0.41
Standard error	0.987	10.75	1.82	13.92
F-statistic	8,87	7.3	8.54	6.8
Prob(F-statistic)	0	0	0	0
Periods included	28	28	28	28
Cross sections included	2163	2157	2272	2259
Observations	21,386	21,315	19,627	19,444

Note: Independent variables' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The variables are winsorised at 99% except BCRISIS. White (1980) cross-sectional standard errors and covariance (corrected for degrees of freedom) are used. ROAA is the return on average assets, ROAE is the return on average equity, LNSIZE is the log of total assets, LEVERAGE is unadjusted capital adequacy (equity/assets), CREDRISK is credit risk (non-performing loans/gross loans), LIQRISK is liquidity/contractual risk (deposits/total liabilities), COSTINC is management efficiency (cost/income ratio), DIVERSIF is diversification (the share of non-interest income in gross revenue), LERNER is the Lerner Index as a measure of competition, BCRISIS is a dummy for banking crisis, RGDPG is the real economic growth rate in terms of GDP and INFLAT CPI Inflation. For more details, see Table 4.

Table A.3.2
Regression results for return on average assets (ROAA) and return on average equity (ROAE) for different types of bank for the period 1990–2018 (estimated by panel OLS with bank-level and time fixed effects).

Coverage	Retail and Consumer Banks		Universal Banks	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Constant	6.22***	64.65***	5.86***	48.04***
	(4.2)	(7.2)	(5.8)	(4.4)
LNSIZE(−1)	−0.296***	−2.59***	−0.248***	−1.81***
	(4.9)	(6.6)	(5.6)	(3.9)
LEVERAGE(−1)	2.311***	−14.26***	1.82***	−14.32**
	(2.9)	(3.4)	(3.2)	(3.0)
CREDRISK(−1)	−3.39***	−32.0***	−2.6***	−25.06***
	(8.8)	(7.8)	(7.7)	(8.5)
LIQRISK(−1)	0.272	0.921	0.302**	4.88***
	(1.0)	(0.4)	(2.2)	(3.9
COSTINC(−1)	−0.00249	−0.0744***	−0.0079***	−0.0735***
	(1.0)	(4.0)	(7.7)	(7.0)
DIVSIF(−1)	0.055	0.728	0.117	0.766
	(0.3)	(0.5)	(1.0)	(0.8)
LERNER(−1)	2.337***	13.28***	1.82***	11.19***
	(6.6)	(5.5)	(9.0)	(6.4)
BCRISIS	−0.165** (2.4)	−3.16*** (3.1)	−0.386*** (4.3)	−5.1*** (4.5)
RGDPG	0.096***	0.8***	0.092***	0.813***
	(5.7)	(7.6)	(7.4)	(11.3)
INFLAT	0.004	0.15	−0.00027	0.0034
	(0.2)	(1.5)	(0.1)	(0.1)
R-squared	0.62	0.47	0.51	0.47
R-squared (adj.)	0.57	0.4	0.45	0.41
Standard error	1.07	10.37	1.59	13.28
F-statistic	12.79	6.88	8.56	7.29
Prob(F-statistic)	0	0	0	0
Periods included	28	28	28	28
Cross sections included	1433	1428	2841	2828
Observations	12,958	12,907	26,450	26,261

Note: Independent variables' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The variables are winsorised at 99% except BCRISIS. White (1980) cross-sectional standard errors and covariance (corrected for degrees of freedom) are used. ROAA is the return on average assets, ROAE is the return on average equity, LNSIZE is the log of total assets, LEVERAGE is unadjusted capital adequacy (equity/assets), CREDRISK is credit risk (non-performing loans/gross loans), LIQRISK is liquidity/contractual risk (deposits/total liabilities), COSTINC is management efficiency (cost/income ratio), DIVERSIF is diversification (the share of non-interest income in gross revenue), LERNER is the Lerner Index as a measure of competition, BCRISIS is a dummy for banking crisis, RGDPG is the real economic growth rate in terms of GDP and INFLAT CPI Inflation. For more details, see Table 4.

Table A.3.3
Regression results for return on average assets (ROAA) and return on average equity (ROAE) for the subperiods 1990–2006 and 2007–2018 (estimated by panel OLS with bank-level and time fixed effects).

Period/coverage	1990–2006, Global sample		2007–2018, Global sample	
Dependent variable	ROAA	ROAE	ROAA	ROAE
Constant	7.42***	67.75***	6.64***	48.5***
	(6.3)	(5.4)	(5.0)	(3.7)
LNSIZE(−1)	−0.323***	−2.59***	−0.279***	−1.92***
	(6.5)	(4.6)	(5.0)	(3.4)
LEVERAGE(−1)	0.53	−25.3***	1.371***	−5.455***
	(0.5)	(3.8)	(2.2)	(2.0)
CREDRISK(−1)	−1.72***	−11.96**	−2.546***	−25.76***
	(3.5)	(2.4)	(6.5)	(7.0)
LIQRISK(−1)	−0.314	−2.14	0.341	5.56***
	(1.2)	(1.1)	(1.6)	(3.6)
COSTINC(−1)	−0.0013	−0.031**	−0.00644***	−0.0638***
	(0.8)	(2.0)	(6.8)	(8.1)
DIVSIF(−1)	0.316	2.27	−0.1	−1.26
	(1.5)	(1.3)	(0.8)	(1.1)
LERNER(−1)	1.99***	11.1***	1.31***	7.46***
	(8.5)	(4.6)	(4.2)	(4.8)
BCRISIS	−0.863***	−8.58***	−0.137**	−1.88**
	(5.9)	(5.5)	(2.1)	(2.0)
RGDPG	0.107***	0.816***	0.0739***	0.708***
	(4.4)	(4.6)	(8.0)	(14.0)
INFLAT	0.0026	0.02	−0.011	−0.0335
	(0.4)	(0.6)	(0.9)	(0.3)
R-squared	0.61	0.54	0.58	0.52
R-squared (adj.)	0.52	0.43	0.51	0.45
Standard error	1.53	12.54	1.32	11.62
F-statistic	6.47	4.86	8.69	6.95
Prob(F-statistic)	0	0	0	0
Periods included	16	16	12	12
Cross sections included	2646	2633	3691	3685
Observations	13,685	13,545	27,328	27,214

Note: Independent variables' coefficient values are reported, and the t-statistics are reported in parenthesis below each estimated coefficient. *** significant at 1%, ** significant at 5%, * significant at 10%. The variables are winsorised at 99% except BCRISIS. White (1980) cross-sectional standard errors and covariance (corrected for degrees of freedom) are used. ROAA is the return on average assets, ROAE is the return on average equity, LNSIZE is the log of total assets, LEVERAGE is unadjusted capital adequacy (equity/assets), CREDRISK is credit risk (non-performing loans/gross loans), LIQRISK is liquidity/contractual risk (deposits/total liabilities), COSTINC is management efficiency (cost/income ratio), DIVERSIF is diversification (the share of non-interest income in gross revenue), LERNER is the Lerner Index as a measure of competition, BCRISIS is a dummy for banking crisis, RGDPG is the real economic growth rate in terms of GDP and INFLAT CPI Inflation. For more details, see Table 4.

Appendix D. Online Appendix - Robustness Checks

Supplementary data to this article -an Online Appendix giving details of robustness checks - can be found online at https://doi.org/10.1016/j.irfa.2021.101989.

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